It will be noticed that a slight change has been made in the list of items in the two preceding estimates. It is because most of the petty mining in Alabama is done by the property owners, who pay the miners and take the whole output of bullion, while in Virginia it is worked on shares independent of the development proper of the mines. On the whole, the estimates for these two states are very uncertain, and of such small proportions that they are comparatively unimportant.

ESTIMATES OF COST OF PETTY MINING, ETC., IN SOUTH CAROLINA.

Amount of petty mining in bullion yield	$913
Number of men engaged therein	15
Average number of days worked during the year	78
Average daily earnings of these miners	$0.65
Probable cost of supplies, etc	$33.48

ESTIMATES OF COST OF PETTY MINING, ETC., IN NORTH CAROLINA.

Amount of petty mining in bullion yield	$48,049
Number of men engaged therein	250
Average number of days worked during the year	160
Average daily earnings of these miners	$0.80

ESTIMATES OF COST OF PETTY MINING, ETC., IN GEORGIA.

Amount of petty mining in bullion yield	$39,172
Number of men engaged therein	200
Average number of days worked during the year	150
Average daily earnings of these miners	$0.85

In these states it is impossible to itemize more than has been done in the above, as the conditions are so different in various sections of the same state and there is such a large amount of petty work. The above figures show pretty well the amount of this work.

ALASKA.

The report on mining in Alaska is furnished by Mr. J. H. Burfeind, special agent.

Alaska is so new and extensive a mining field that it may be expected to become a permanent, though perhaps not very abundant, source of supply. The ores thus far milled are chiefly low grade, occurring in large amounts, thus promising a permanent, though not rapid, increase. The gravel deposits, like those of all far northern countries, are of very limited extent.

Exact information respecting the actual amount of gold and silver produced in this territory can not be obtained. This refers especially to placer mining, which is carried on in a great many places beyond the reach of transportation, and at some places unknown except to the discoverers. Respecting quartz mining, more exact figures are obtainable. The deposits at mints and the reports from express companies are usually reliable guides as to certain facts, but neither can be so considered here. Most miners carry their gold dust themselves to market, to San Francisco (California), Portland (Oregon), or Victoria (British Columbia), and these respective states and provinces are credited with producing large amounts of gold which in reality come from Alaska.

Previous reports have been made relating to the earlier discoveries of placer mines. This description will be confined to what has been done since 1880.

SILVER BOW BASIN.

The placer mines at this camp were discovered late in the fall of 1880. Many miners arrived during the following winter, and the present town of Juneau was started during 1881. A small amount of gold was produced that year, but the seasons of 1882 and 1883 were the best, and most of the best available ground was worked. Since that time much labor and the outlay of large sums of money have been required to get the ground into condition for working. During 1889 about $50,000 was produced, and fully eight-tenths of this by 2 private companies, in which men combined their labor and money. Even these 2 successful companies have lately sold their rights and interests to the Silver Bow Basin Mining Company. This company is now running a tunnel 2,600 feet long. The general opinion is that the company will take out more gold than has been taken out of the camp up to this time. The location warrants this to a certain extent.

Quartz mining in Silver Bow basin has been thus far unprofitable, not because there is no gold ore, but on account of the unsuitable works built there. There are ores in Alaska which can not be treated with profit by plant similar to that used at the Treadwell mine.

Between Silver Bow basin and Juneau is a syenite belt, and in it are found many veins. The Dora and Yukon Union group produced considerable gold considering the amount of work done.

DOUGLAS ISLAND.

Placers were discovered here during 1881, and had produced about $50,000 when work was stopped. The working of these placers laid bare a very large body of low-grade quartz, which was located as the Paris mine, which the owner, not considering of much value, sold, with a few adjoining claims, to Mr. John Treadwell for a few hundred dollars. The quantity of ore was satisfactory, but the average quality had to be learned, and development work was started at once in a systematic way. As soon as Mr. Treadwell and his associates were satisfied that with proper works the ore would yield a good profit they began building a 120-stamp mill. After this mill had run successfully for several years another 120 stamps were added, and not one of these stamps has remained idle a day for want of ore; however, 4 or 5 days have often constituted a month's run on account of scarcity of water. Steps are being taken to avoid this trouble. The ore body, where it is worked at present, is above 550 feet wide and is quarried in open pits, a few power drills being ample to break 600 tons daily. No assorting is done, everything between the walls going to the mill. The ore consists mainly of quartz and calcite, carrying free gold and gold-bearing iron pyrites. The free gold is amalgamated in the batteries and on plates in front of them, and whatever gold or amalgam may escape from the plates is saved in mercury traps. The pulp, thus freed from the metallic gold, goes to the Frue concentrators, where the gold-bearing pyrites are separated from the worthless gangue and the concentrates are taken by tramway to the roasting furnaces, on the top of which they are dried.

There is 1 reverberatory, 13 feet by 65 inches, inside measure, and 6 double Hammond-Spence furnaces. The gold is extracted from the roasted material by the Plattner process. Of the gold in the raw sulphurets 93 per cent is found in the melter's bar ready for shipment, the loss being only 7 per cent.

There are other producing mines on Douglas island. The Mexican group, adjoining the Treadwell on the southeast, now being opened, is expected soon to enter the list of producers.

SHEEP CREEK.

This camp has only come into notice since 1888. The Silver Queen is the only producing mine yielding a high-grade silver ore. It contains some gold also. The first-class ore is shipped, while all ores under $100 per ton assay value remain on the dumps awaiting some other treatment. The shafts and tunnels on this property show the ore bed to be uniform in size and quality. There are several other claims on this ledge that have good indications. The Gould and Currier claim is a different ledge, and the ore carries principally gold, with a small amount of silver. Not enough work has been done to demonstrate the extent of the ore body, but the ore taken out for the purpose of development is sufficient to more than pay for the money expended, which can be said of only a few mines. It is to be hoped that the different owners of claims in this camp will continue to work, as by doing so they have every indication of meeting with success.

SUMDUM BAY.

In the summer of 1889 two good discoveries were made here. On the Sunnyside lode is found a purple copper ore (bornite) carrying up to several hundred ounces of silver per ton. At another part of the bay rich gold ore was discovered late in 1889. A mill run made by Mr. Thomas Price at San Francisco shows that the ore averages $300 per ton in gold, and the test made indicates that it can be worked very cheaply. The owners are diligently investigating their discovery.

GLACIER BAY.

Silver-lead ores have been discovered here, but as yet work has been insufficient to demonstrate the value of the discovery.

ADMIRALTY ISLAND.

The large bodies of low-grade ore found here have, as far as investigated, proved too low in gold to justify working. At Funter bay, on this island, small veins of good grade gold ores are found, but further development work is necessary to determine quantity and quality, and the discoverers and owners are now erecting a small Huntington mill.

BERNERS BAY.

This district was entirely neglected in 1889, nothing but assessment work having been done. It is to be hoped that the promising properties here will receive more attention, as the work on the Comet, little as it is, shows a good body of excellent ore, and the work on the Uncle Sam and Golden Brown, which exceeded the necessary assessment work this last season, has met with results sufficient to encourage other owners of claims.

YUKON.

The discouraging reports about unwholesome provisions and the difficulties encountered in getting to Yukon and back have deterred miners from going there, but those who have settled down to work appear to do very well.

At Snettisham bay good ore is said to have been found, but there is no information regarding the claims worked, which indicates that the few miners have met with good success, especially when the difference between the production of 1880 and 1889 is taken into consideration.

Nothing like actual facts regarding the production of placer gold from the Yukon region can be obtained. Mr. W. F. Reid thinks, to judge from the amount of gold brought out by way of Juneau, that every man had an average of $800, and thinks there are fully 175 miners at work there, which would indicate a production of $140,000 annually. It should be placed very much lower, however, as those who actually worked usually returned by way of Juneau, while those who prospected all along the river mostly returned by way of San Francisco, and with very little gold. The actual proportion of the 175 who are miners and actually at work is not, however, known, and $75,000 will doubtless fully represent the output last year.

ARIZONA.

Arizona contains great possibilities, though the output has been almost stationary for many years. The climate is less favorable than in some other sections, and the lack of railroad communication to many promising districts has retarded the development of what will eventually become an important factor in both gold and silver production.

CALIFORNIA.

California, the great pioneer in the gold-producing industry, is of all the states unquestionably the most liberally supplied by nature with this metal. Its placers are the most extensive and richest that have ever been discovered, and they are still far from being exhausted, though many of the most important and accessible beds have been washed over. The recent antidébris legislation in California forbidding the working of hydraulic mines has lessened the production of the metal and threatens the almost entire destruction of this very important industry. In its silver production California has for years been almost stationary.

The following is an abstract from a particularly valuable contribution made to the director of the mint by Mr. Charles G. Yale, who was also the special agent of the census for this state:

The principal mining industry of California is that connected with the extraction of gold from quartz and gravel, and the state still continues to hold first place in the list of states and territories in the matter of gold product from year to year. In the earlier history of gold mining in California the main portion of the precious metal was procured from the placers or surface washings in the gulches, cañons, and river bars and beds, and for many years an enormous yield was maintained from these sources. Gradually, however, as was to be expected, the area available for this kind of mining was narrowed as ground was worked out, and then attention was turned to other sources of gold supply.

Finding, as the miners of those days did, these auriferous deposits only at certain points, they very naturally looked near by for the source of the free placer gold. This led to the search for quartz veins, and also for the large bodies of auriferous gravel which were contained in the hills of the mining counties of the state. In time the gravel deposits were found and located and the quartz ledges opened and developed. Then the character of the mining and the character of the mining population changed. It was no longer possible for a nomadic miner with pick and pan to gather a fortune in a few days from a deposit which nature had concentrated for him in a few yards of earth. It became necessary to employ capital as well as labor in the mining operations of the state. Companies took the place of the individual miner, built ditches to bring in water to the gravel claims, and mills to crush the ore from the quartz veins. The miners gradually stopped working for themselves and were employed by the companies for daily wages. They became more settled in their habits, gave up their nomadic instincts, and became permanent residents of the little mining camps and larger mining towns, where they were sure of steady employment in the mines or mills. Of course there are still many prospectors in the mountain counties as well as miners who are working their own claims, but the majority of the mining population is now engaged in work for the companies, who are operating the mines on a more extensive scale than is usually possible for individuals.

The era of speculative mining incidental to newly-settled mining regions has also passed by in California.

It may be confidently stated that the quartz industry of the state is in a better condition to-day than it has been since its inception. The appliances for saving gold which have been perfected are applied intelligently and carefully, and every effort is made to gain a large percentage of the gold that is in the ores. The sulphurets are no longer allowed to go to waste, but all mills are now supplied with concentrators for saving this valuable product for subsequent treatment. Some of the larger mills have their own chlorination works for treating sulphurets, but those which have not find no difficulty in disposing of the concentrates to establishments which make a specialty of working them. The value of the sulphurets is usually subordinate to the value of the free gold in the ores, but in the total product form an important factor. The average value of the sulphurets saved in the state may be placed at from $80 to $90 per ton of concentrates, but it, of course, may take many tons of ore to yield a ton of these concentrated sulphurets. The percentage of sulphurets will vary from 1 to 5 of the ore milled. These sulphurets are iron pyrites principally.

What are termed low-grade ores vary in value from $3.50 to $8 per ton in gold, and high-grade ores are those yielding from $15 to $30 per ton. The average value of the ore treated at present may be stated at $10 to $12 a ton. In the low-grade ores the gold can seldom be seen with the naked eye, but the high-grade ore often shows particles of free gold. Mineralogically the ores worked consist generally of a quartz gangue, carrying free gold and iron pyrites. Quartz is the characteristic matrix of the veins, though other matrices occur.

The milling of gold ores in California has been greatly perfected of late years, and it is now possible to work ores profitably that 10 years since were practically worthless. This has come about by the adoption of more economical methods in both mine and mill and greater care in the handling of the ore, as well as increased knowledge of the proper way to treat the ores in the mill. Improved appliances are also important factors. The present form of stamp mill combines durability of construction with an automatic simplicity in the manipulation of the ores. The important object in the treatment is to secure the largest yield consistent with the least waste of the precious metals by the adoption of the most rapid, simple, and economical method of reduction and amalgamation.

Briefly, the process of treatment may be described as follows: The ore from the mine is conveyed to a chute above the rock breaker floor, where it is discharged upon a grizzly, which consists of an arrangement of iron bars framed and inclined downward and so set as to permit only the smaller and suitable-sized fragments to fall into the ore-feeder bin below, while the larger masses slide down over the grizzly to the rock breaker, which crushes them to proper dimensions and discharges them into the ore-feeder bin and hopper. From here they are automatically fed as required to the battery stamps in the mortar, where they are pulverized, and quicksilver being introduced to the pulp an amalgamation of the freed particles of gold is accomplished and the resulting amalgam retained on the silver plates fitted within the mortar.

A suitable amount of water is introduced into the battery with the ore, and this, with the "swash" of the stamps, forces the ground pulp and amalgamated particles through fixed screens out of the mortar upon an inclined table or apron of such a width as to permit a thin stream of water and pulp over the silvered plates with which this apron is covered, where the stray amalgam and liberated particles of gold are caught. The remaining sands flow on concentrators, which by their peculiar action retain the heavy and metallic particles and discharge the lighter and worthless portion. Where water power is abundant this waste, or "tailings", is sometimes again worked in arrastres to catch anything which may have passed the appliances described. The concentrations caught in the concentrating machines are accumulated in proper receptacles and retreated, either by further pulverization and amalgamation in grinding pans and settlers or by chlorination or other process, as the character of the chemical combinations may require.

Although some of the sulphurets obtained by the concentrators are treated at smelting works, most of them are treated in California by the Plattner chlorination process. This consists in roasting the concentrates in reverberatory furnaces to drive off the sulphur, arsenic, and other deleterious substances. Salt is added as the roast nears completion. The thoroughly roasted and moistened concentrates are charged into impregnation vats, through which chlorine gas is passed. The chlorine gas attacks the gold, forming with it terchloride of gold. Then water is added to the vats, by which the terchloride of gold is leached out. The lixivium is run into precipitating tanks, where, by the addition of a solution of sulphate of iron, the gold is precipitated. The gold is collected upon filters, thoroughly washed, dried, and melted. The chlorination gold averages from 0.999 to 0.9995 fine. If there is silver in the concentrates, as often happens, it is leached out and reduced to a metallic state. A chlorination plant with a capacity of 6 tons in 24 hours costs from $6,000 to $7,000, and it will cost such a plant about $10 a ton to treat the concentrates. From 90 to 92 per cent of the gold value of the concentrates is recovered. At all important mining points in the state there are now custom chlorination works, which charge about $20 per ton for treatment and guarantee about the above-mentioned percentage of returns.

Machinery for concentrating the sulphurets has attained considerable perfection of late years, and there are many forms on the market. The most popular and generally used are those forms which employ an endless rubber belt, near the head of which the pulp is fed. The belt is slightly inclined and is given a shaking motion, so as to keep the particles in agitation. The sulphurets settle on the belt, and, adhering to it, are carried over the head of the table and deposited in a tank or box beneath. The specifically lighter particles are carried downward and pass, as "tailings", to the blanket sluices outside the mill. These are the general features of this class of machines, which, however, vary in details of construction and operation to some extent, and each kind has its advocates. Many mills have from 100 to 200 feet of blanket sluices with a grade of from 1 inch to 1.25 inches per foot, and the stuff, after passing over the concentrators, is led to and flows through these blanket sluices. The sands collected on the fibers of the blankets are usually ground in a pan used for that purpose, though essentially like those used in silver mills.

The introduction of rock breakers and automatic ore feeders has greatly increased the effectiveness of stamp mills as compared with breaking rock and feeding the battery by hand. The use of the feeders is considered to have increased the capacity of the battery from 15 to 20 per cent, besides effecting a very considerable reduction in the wearing of screens, dies, shoes, etc. As to the duty of stamps, the number of tons crushed depends on several things, but chiefly upon the character of the ore. Hard ores and those of a clayey nature decrease the duty of the stamps. The average duty of the stamp in this state is approximately 2.25 tons of ore in 24 hours. Within a short time a great improvement has been made in the matter of steel shoes and dies for quartz mills. Formerly, owing to their tendency to chip and cup, their introduction met with little success. In most mills, where transportation is an important element in the cost, steel shoes have replaced the iron ones formerly used. Recently chrome-steel shoes and dies have been introduced and have proved their superiority over most other kinds of steel used. In some mills steel shoes and iron dies are used. The iron dies wear more evenly with steel shoes than the steel dies do. The life of the steel is about 2.5 to 3 times that of iron shoes and dies, and the cost about twice as great as that of iron.

In the matter of plates for the aprons of gold mills silver-plated copper has almost everywhere superseded the ordinary amalgamated copper plates. They are more easily kept clean and the coating of amalgam that forms is very effective. In fact, there is a constant absorption of amalgam by the plates. At the Empire mill, Grass Valley, Nevada county, notwithstanding the fact that the plates were well cleaned every day, the "sweating" of the outside battery plates and the aprons from 4 batteries yielded $19,000 worth of amalgam after 1.5 years' run.

The loss of quicksilver per ton is variable. 1 ounce per 2 tons of ore (1 pound for 32 tons) is about the mean quicksilver loss for the mills of the state. The quicksilver loss occurs generally through its being "floured" and floated off with the water in extremely finely divided particles.

As to percentages saved and cost of milling gold ores, Mr. John Hays Hammond, M. E., an authority on this subject, says:

> The average value of the ore worked is the value of the gold saved, plus the value of the sulphurets saved plus the value of the tailings lost. From these factors is calculated the percentage of gold saved by the mill. This represents the efficiency of the process. Other things being equal, this will vary with the character of the ore. Where the gold is very fine and where the sulphurets are of a brittle character the percentage saved will be less than in the treatment of more favorable ores. Most of the loss occurs in the loss of sulphurets, consequently ores carrying a large percentage of rich sulphurets may have comparatively rich tailings. There are few ores in mines in operation in California from which 80 per cent and upward of the assay value can not be extracted by skilled mill men with good mills. The majority of mills save at least 75 to 85 per cent of the assay value of the ores. Careful investigation at the North Star and Empire mills, carried on for 1.5 years, shows a saving of from 82 to 94 per cent of the assay value. The usual percentage saved, according to reliable semimonthly reports from these mills, is from 86 to 90 per cent of the assay value of the ores. In these estimates of course no deduction is made for the loss of gold in the subsequent treatment of the sulphurets, usually unimportant in this connection.

USUAL COST OF MILL LABOR IN CALIFORNIA PER 24 HOURS.

1 man at rock breaker, at $2.50	$2.50
2 amalgamators, at $3	6.00
3 concentrators, 1 at $3 and 2 at $2.50	8.00
Total	16.50

The rock-breaker man also attends to the blanket sluices, and is employed in other tasks about the mill. Where steam power is employed in addition to the above force, 2 engineers and 1 man to pile the wood near the boilers, etc., are required.

The following is the usual cost of milling per ton in a 40-stamp gold mill (water power) with a capacity of 80 tons per 24 hours:

COST PER TON OF GOLD MILLING IN CALIFORNIA.

Labor:	
Mill labor	$0.205
Assaying, retorting, and superintendence	0.025
Total	0.230
Supplies:	
Castings	$0.070 to $0.100
Quicksilver	0.015 to 0.040
Lubricants, screens, illuminants, machinists' time, incidentals	0.040 to 0.080
Total	0.355 to 0.450

To this must be added the cost of water power, which is very variable. Where steam power is used the above estimate should be increased about 10 cents per ton for labor. Repairs, lubricants, etc., incident to the use of steam-power plant increase the cost about 1 cent per ton. An electric plant to illuminate the mill, the office, etc., costs about $600. The cost of producing the light is but little beyond the cost of power to run the dynamo. Good illumination is very desirable about a mill. The charge for assaying, retorting, and superintendence is based upon the salary of $120 per month for a man to perform these duties, in addition to rendering other services, that is, clerk, timekeeper, etc., about the mine. One half of his time is charged to the cost of milling, while the other half is charged to the cost of mining. At some works the superintendent of the mine performs these duties.

Although the ordinary stamp mill still continues to maintain its prestige for the reduction of ores in California, it is proper to state that within the past few years various forms of roller mills and other forms of pulverizers have been largely put into use, especially on small mines, where the owners were unwilling or unable to go to the expense of erecting stamp mills. There are several types of the pulverizers, varying more or less in principle, but forming in themselves complete ready-built mills, simply needing a foundation to be ready for work. These cost much less than stamps, and have been found very effective on certain classes of ores. In fact, their use is increasing gradually, as they are well adapted for prospecting mills and for mines owned by individuals or small companies. There are some persons who advocate their use in preference to the stamp, while others do not believe in anything but the stamp for crushing ore. However, numbers are made, sold, and put into use, and in certain instances their effectiveness can not be doubted.

As to the extent of the quartz industry, some idea may be given from the appended list of quartz mills, as this list will show the relative importance of the different counties of the state. It should be borne in mind that the larger portion of the mills enumerated are only run during the water season, and some are "custom mills", which run whenever supplied with ore. As most of the California mills are run by water power, it will be understood that unless other power is mentioned water is employed.

QUARTZ MILLS.

Counties.	Mills.	Number of stamps.	Remarks.
Amador	Amador gold	60	
	Amador Queen	20	
	Bunker Hill	40	Water or steam.
	Gover	20	
	Kennedy	40	
	Keystone	40	Water or steam.
	Lincoln	40	
	Live Oak	2	
	Loyal Lead	10	
	Mahoney	40	
	Moore	10	
	Nevills	10	
	Oneida	10	
	Plymouth Consolidated Mining Company.	160	
	South Spring Hill	30	
	Sutter Creek	10	
	Wildman	10	
	Zeile	40	Water or steam.
Calaveras (*a*)	Blazing Star and Water Lily	3	Steam.
	Esmeralda	10	Do.
	Ilex	40	Steam and water.
	McCreight	10	
	Russell Reduction and Mining Company.	5	Steam and water.
	Sheep Ranch	30	Steam.
	Stickles	20	
	Suffolk	5	
	Utica mine	60	
Colusa	Manzanita gold mine	10	Steam mill.
Eldorado (*b*)	Alpine	10	
	Big Canyon	20	
	Chili Ravine	10	
	Church	10	
	Gopher and Boulder	20	
Eldorado—cont'd	Josephine mine	20	
	Linden gravel	10	
	Melton	15	
	Oregon	10	
	Pacific	20	
	Rogers gravel	10	
	Superior	10	Steam.
	T. Taylor	10	
	Vandalia	5	Steam.
	Zentgraft	10	
Fresno	Abbey	10	Steam.
	Confidence	5	
	Hanover	5	Steam.
	Josephine	20	Do.
	Last Chance	10	Do.
	Providence	....	Steam, Dodge pulverizing mill.
	Samson	....	Steam, Kendall mill.
Lassen	Evening Star	10	
	Golden Eagle	5	
Los Angeles	O'Reilly mine	5	Steam.
Mariposa	Cranberry	....	2 arrastres.
	Hathaway-Bondurant	10	Steam.
	Hite	40	
	Red Cloud	22	Steam.
Mono	Monte Cristo	....	Steam, 2 Huntington mills.
	Standard Consolidated	15	Steam.
Monterey	Last Chance	3	Do.
Napa	Palisade silver	10	Do.
Nevada	Blue Bell	10	
	Brunswick	20	Steam.
	Champion	10	
	Champion	....	1 Huntington mill.
	Crown Point	10	

a The Maltman reduction works, run by steam, have also 1 Tustin pulverizer; the Russell Reduction Company, 1 Dodge ore pulverizer; Angels mine, 3 low pulverizers; Quaker Hill, 1 6-foot Huntington mill; Buena Vista (steam), 1 Kendall rocker mill.

b The Shaw has a 5-foot Huntington pulverizer, and the Mathines Creek a 5-foot mill of the same pattern.

QUARTZ MILLS—Continued.

COUNTIES	Mills.	Number of stamps.	Remarks.
Nevada—cont'd	Delhi	18	
	Empire	40	
	Excelsior	10	Steam.
	Gaston Ridge	10	Do.
	Idaho	35	
	Larimer	10	
	Mayflower	4	
	Nevada	10	
	North Banner	5	
	North Star	30	
	Omaha Consolidated	10	
	Orleans	8	Steam.
	Rocky Glen	10	
	Rodgers	10	
	Spanish	....	4 Huntington mills.
	Washington	20	
	Yuba	15	
Placer	Bells	....	1 Kendall rocker mill.
	Breece & Wheeler	10	Steam.
	Buttes	5	
	Dardanelles	5	
	Dorer	10	
	Jamison	....	Arrastres.
	Kidd & Johnston	5	
	Live Oak	5	
	Morning Star	10	Steam.
	New	5	
	Saint Patrick	15	
	Shipley	10	
Plumas	Crescent	16	
	Green Mountain	60	
	Kettle Mill	20	
	Plumas Consolidated	24	
	Plumas Eureka	60	
San Bernardino	Barbero	10	Steam.
	Hawley	10	Do.
	Waterloo	60	Steam, new.
	Waterloo	15	Steam, old.
San Diego	Ready Relief	10	Steam.
	Stonewall	10	Increased to 30.
Santa Cruz	Stribling Mill	5	Steam.
Shasta	America	5	
	Calumet	24	2 Paul dry pulverizers.
	Celestine	5	
	Central	....	2 Huntington pulverizers.
Shasta—cont'd	Gem Consolidated	10	Steam.
	Lost Confidence	20	Do.
	Majara	18	Do.
	Reilly & Bliss	10	
	Uncle Sam	10	Now 50
Sierra	Gold Bluff	12	
	Rainbow	10	
	Sierra Buttes	80	
	Young America	40	
Siskiyou	Black Bear	32	Water and steam.
	Caribou	2	
	Comstock No. 2	5	Steam.
	Daggett & Smith	5	
	Evening Star	4	
	Hooper's Custom	5	Steam.
	Johnson's Oro Fino	10	
	Luna	4	
	Methodist Creek	1	
	Mount Laurel	16	
	Schroder & Warner	5	Steam.
	Scott Bar	10	
	The Cilta	4	
	Uncle Sam	8	
	Warren & Green	5	
Trinity	Bartred	10	Steam.
	Brown Bear	15	Do.
	Bullychoop	5	Do.
	Golden Chest	5	
	North Star	5	
Tuolumne	App	5	
	Belcher Consolidated	....	Steam. Kendall oscillating mill.
	Black Oak	10	Steam.
	Buchanan	20	Do.
	Consolidated Eureka	20	
	Experimental Gulch	10	
	Gem	10	
	Heslep	25	
	Hidden Treasure	....	Steam, Huntington pulverizer.
	Kanaka	5	
	Madrid	5	
	New Albany	10	
	Patterson	20	
	San Guiseppa	....	Arrastres.
	Seeber	15	

Idle or inactive mills are not included in this list. Additions are commonly made to the number of stamps as the mine development and output of ore demand.

One reason for the increased activity in quartz mining in California of late years is the very general adoption of water power as a motor, thus cheapening operations. In most of the mining sections water is available, and the storage reservoirs built by the hydraulic miners are now utilized for water supplies to the quartz mines. As a general thing this water is brought in with a high head or pressure, so that there is plenty of power. This feature has had the effect of bringing to a profitable point quartz ventures that were not paying when steam was used.

It is worthy of note that many mines abandoned years ago have been reopened and worked recently, the conditions having changed. In the first place, the miners can work ore much more cheaply than in former years, and supplies are cheaper, means of transportation better, and knowledge of mining increased. The Stonewall mine, in San Diego county, for instance, was abandoned for 10 years and filled with water. It was purchased by the governor of the state, who reopened the mine and equipped it with a fine milling plant and other improved machinery, so that it is very profitable. Many other instances of a similar character might be cited.

Hydraulic mining was at one time the source of a large annual output of gold in California, and millions of dollars were invested in the mines, reservoirs, ditches, flumes, and plants. Litigation arose between the mine owners and the owners of lands along the rivers below the mines, owing to the débris or tailings from the mines injuring the farming lands and navigable rivers. Long-contested trials resulted in most of the mines being closed down under injunction by the United States courts, and they still remain idle. These injunctions affected the hydraulic mines in the tier of counties extending from Shasta to Calaveras. However, the counties of Siskiyou, Trinity, and Del Norte, in the northwestern angle of the state, have many hydraulic mines in operation, and this is the principal branch of mining carried on there. The conditions for this branch of mining are exceptionally good along the Trinity and Klamath rivers and their tributaries. In that region there is no valid objection to hydraulic mining being carried on, the streams not being navigable and the débris question not being an important one. During the past 4 or 5 years hydraulic mining operations have increased in the 3 counties mentioned, and large extents of ground are being developed with first-class plants.

Owing to the practical stoppage of this class of mining in large portions of California, no improvements of note have been made of late in the methods of carrying on the operations.

In some places this kind of mining is carried on in a small way by using what are called débris dams. These dams are obstructions placed across the beds of streams for the purpose of holding back the sand and gravel coming from the mines to prevent their entering into the navigable streams and damaging the land in the valleys below. They are placed either in the mountain cañon or in the valleys where storage room can be conveniently arranged. The dams are made of stone, wood, or brush, as circumstances require. The structures are not designed to impound water, but simply to check the velocity of the current carrying the mining and other débris and to allow the deposit of the material behind them, and therefore they partake more of the character of retaining walls than water dams. Some large mines which built débris dams were also enjoined from hydraulic mining by the courts, notwithstanding the dams, on the ground that the waters of the streams were muddied by the overflow waters from said débris dams, all the matter in suspension not having been precipitated and retained. A commission of United States engineers, under instructions from Congress, is now engaged in examining into the whole question of hydraulic mining in California and its effects upon the streams, with a view of finding the actual damage done by the débris from the mines, and also to see if there is any practicable way to permit the mines to be worked without damage to property or rivers. This commission will make a report to Congress on the subject. In hydraulic mining water is made to do the work of moving the material by being brought under heavy pressure and in large volumes against the gravel banks. These banks are first shaken or loosened by heavy blasts of powder, and when the water is turned through the nozzles against the bank the gravel is torn down and washed through the long line of sluices, undercurrents, etc., and the gold caught, the débris or tailings passing on into the cañons, streams, and rivers. The heavy portion soon comes to rest, but the lighter sands often go for some distance before being deposited, and it is these sands, filling up the rivers, which brought about the "débris question" in California.

It is a very expensive operation to equip one of the claims, because the gravel bank is worthless unless an abundance of water can be supplied. Therefore the companies must construct reservoirs, ditches, flumes, etc., and lay a line of pipe to bring the supply under pressure to the point where it is to be used. Then, again, very expensive bed-rock tunnels must also often be made to get rid of the tailings, for there must be "fall" for this débris to pass on out of the way. For these reasons the business of hydraulic mining is generally carried on by companies of capitalists, the expense of opening and equipping one of these mines being beyond the means of the individual miner or prospector.

Before the injunctions of the courts stopped the large hydraulic mines of the state a machine was in use for working shallow banks and low deposits in basins and creeks, called the hydraulic gravel elevator. Many valuable auriferous deposits are found in basins and flats lying along creeks far too low to be underrun by bed-rock tunnels, open cuts, or drains at any cost, and these deposits had to be worked by shovels and barrows, whims, engines, derricks, and pumps. To overcome these difficulties and to dispense with the use of expensive pumping plants, the hydraulic elevator was devised and put in use. It was at first looked upon with some doubt as a practical apparatus to do any work on a large scale; but when the large mines were prevented from working by the ordinary hydraulic method this appliance was tried in these claims and has been found to answer the purpose of working them, though on a more limited scale than was practiced by the old method.

The principle upon which the operation of these hydraulic gravel elevators is based is that of driving gravel up hill by hydraulic force. It is only necessary to give the impelling water more velocity than it has through an ordinary flume to make it acquire sufficient force to carry gravel up an inclined plane. This fact suggested the construction of a form of machine which should so direct and confine the inherent hydraulic force of a stream of water as to impel before its power masses of earth and gravel.

These hydraulic gravel elevators are simple in construction. An inclined pipe or closed box, open at upper and lower ends, is placed in position and the open end of the ground section is concave in shape, or a lower half-section of pipe flaring outward, into which earth, sand, and gravel are sluiced by hydraulic giants through bed-rock flumes leading thereto. This lower end is set into a chamber or hole excavated below the surface bed rock. The material sluiced into this lower entrance is taken up by a stream issuing from a fixed hydraulic nozzle, which by its force impels it upward through the pipe to its point of discharge into the open flume above, whence it is carried away through a line of sluices to a final dump. Confined as the material is within this tight iron box, it goes as fast as the stream itself, and as the gravel is acted upon by the full force of the water from the hydraulic nozzle the gravel is disintegrated by this action. The practical operation of these machines has determined the fact that when properly and advantageously set and operated the amount of water and material which can be raised and impelled through the upraise pipe is governed and limited only by the volume of water used, acting under its given head or pressure, and the carrying capacity of the pipe. The character of the gravel deposits, whether good piping ground or hard, compact conglomerate, governs the size of the hydraulic giants used, and consequently the quantity of water requisite for piping purposes. The greater the pressure and volume at command the larger the quantity of earth and gravel that can be raised.

These machines are being worked in various parts of the state, where the vast areas of ground which have been piped out in the past are utilized as reservoirs for impounding the débris which may be hydraulicked by the elevator system. The gravel from the standing banks is washed down by giants, sluiced to the elevator, and forced up, as described, to such points that it may be led to old workings or pits and there retained, and not flow into the streams, the gold being retained in the sluices and other gold-saving appliances. Without this apparatus for elevating and throwing back the débris many mines would be unable to impound their débris without very great expense, since old workings can be utilized as débris reservoirs.

The future of drift mining in California is promising. The better knowledge of the character and situation of the buried auriferous channels and the more systematic methods of exploration and mining have taken away much of the uncertainty which caused so many failures among the earlier drift-mining operations.

River bed and bar mining are not so common in California as in early days, most of the rich bars on the rivers having been worked out. In some places, however, these bars are being worked over and over whenever the stage of the water permits. Up on the Klamath, in Siskiyou county, there is still a great deal of river mining going on, the miners using the old-fashioned "wing dams" and wheels to get at their claims. There is more of this class of work now going on in the extreme northwestern counties than elsewhere in the state.

Several attempts have been made in the last few years to turn aside an entire river in order to get at the gold in the bottom, but none of these large enterprises have so far been successful. On the Tuolumne river, near Jacksonville, a short distance from Chinese Camp, a large amount of money was expended in building a dam and flume to get at the river bed, and although about $16,000 was obtained in one hole 5 feet deep and prospects looked well, the waters washed away the dam and flume and the investment was lost.

On the Big Bend of the Feather river, Butte county, the Big Bend Mining Company ran a tunnel about 12,000 feet long (which, being found to be too small, was enlarged in dimensions to 13 by 16 feet), built a dam, put in sluices, pumps, electric plant, and spent immense sums in laying bare some 14 miles of the river bed, but no returns have been received, and the projectors report the enterprise a failure. On the same river and above this claim the Golden Gate Company built a dam 50 feet high, a flume 50 feet wide and 3,300 feet long, and were about to begin work in the exposed river bed, when a sudden rise in the river washed away the dam and flume and stopped operations. A new dam and flume will be built this year and work started over again. Many people believe that large amounts of gold will be taken out of these claims, but thus far, notwithstanding all the money spent and precautions taken against accident, none of these enterprises have been successful.

Two notable discoveries have been made in the coast range within the past few years, and the old theory that there would be no gold mines of value in that range has been disproved. Los Burros district, in the southern end of the Santa Lucia range, Monterey county, was first worked for quartz in 1887, and now there are some 25 claims, of which the Cruikshank is the most important. The ore is free milling, containing both silver and gold, the latter predominating. Placer gold is also found, which is rough and angular, evidently coming from the ledges near by. A number of men are now at work in this district.

In Napa county, on the lower slopes of Mount Saint Helena, silver mines have been found, and one, the Palisade, has a 10-stamp mill in operation. The ore produces about 30 ounces a ton.

The silver-mining interests of California are small as compared with the gold. Silver ore is found in the following counties of the state: Alpine, Mono, San Bernardino, Napa, Fresno, Kern, San Benito, Sierra, Siskiyou, and Inyo. The principal silver district is that of Calico, San Bernardino county.

MINES AND MINING IN PLACER, SIERRA, AND YUBA COUNTIES, CALIFORNIA.

The following report is furnished by Mr. R. L. Dunn, special agent:

PLACER COUNTY.

The mines and mining industry of this county is divisible for detailed consideration as follows: (1) gold-bearing quartz mines; (2) gold-bearing drift placer mines; (3) gold-bearing hydraulic placer mines; (4) river bed and bar placer mines; (5) tailing placer mines; (6) surface placers and the rocker and sluice mining of placers on a small scale without plant. Their relative importance is as stated in the order of the classification, except that at the present time drift mining may be of somewhat greater magnitude than quartz mining. Each of the 6 kinds of mines is in turn divisible into 3 groups, viz: (1) locations and mining claims not yet developed and on which there has been little or no expenditure, and in many instances will be no more; (2) mines either producing or being actively developed to the producing point, including mines on which there has been expenditure, but whose permanent development work is being done on adjacent mines; (3) mines that are worked out and practically abandoned. The schedules returned by the special agent have been of mines of the second class or kind only. There are probably twice as many locations and claims in the first class of which no account has been taken, as they have produced nothing, and not to exceed $5,000 in the aggregate was spent on the entire number in 1889. Their inclusion would only increase the values on estimates built on nothing more substantial than hopes and make a false proportion between values and production and expenditures.

Drift mining as an industry has certain peculiarities as to values that make an explanation pertinent. The underground improvements, tunnels, drifts, etc., are very largely made in connection with the mining out of the ground, the first dead expenditure of opening in many instances being nominal, and then the extension of the tunnels and drifts is paid for out of the product of the mine as a current expense account rather than an investment of so much capital. A drift-mine tunnel may be 10,000 feet long, costing $100,000, yet it only represents the expenditure of $5,000 of capital, the remainder of the money having come from the current product of the mining. The mine of course lessens in value as the ground is more and more worked out, yet the extent and expenditure of necessary tunnels and drifts constantly increases. The hydraulic mines of Dutch Flat and Gold Run districts, which may virtually be considered as one district, as the gravel deposit mined is the same in both, are all enjoined from mining. In other sections of the county, where injunctions have been threatened, it was impossible to find acknowledged owners to any of these properties; but this was the only section in 3 counties where hydraulic mining is carried on in which the special agent could get no information. In other hydraulic mining districts of the county full and reliable information was given, and the miners were generally anxious to show the magnitude of their interests which were affected by injunctions from the farming interests of the Sacramento valley.

Regular book accounts are kept only by incorporated companies, except perhaps a blotter or simple record of receipts and expenditures where there are partners, and few books show segregated accounts either for current expenditures or for the investment of capital in plant and mining. With river bed and bar and tailing placers the season is from January to January, other mines from June 30 to June 30. Hydraulic mines are not operated in the summer, and river mines are not operated in the winter.

River bed and bar mining is of such nature that a spot is mined out in one year and a new place taken the next season. These mines are therefore not permanent in character, and all information concerning their operations is open to question.

Concerning the gold product, the larger part is shipped by express to the mint and assay offices in San Francisco. Another large part, including the entire product of some mines, is taken directly to San Francisco and finds its way to the mint and assay offices from first hands or through the banks. The gold product of small surface mines is generally bought by storekeepers and local bankers, also nearly all of the gold taken out of the tailing mines by Chinese, who have a practical monopoly of this kind of mining.

Miners in this county are employed an average of not less than 275 days in the year, and when the season for one kind of mining is ended they are employed in other branches, and in the case of assessment work the same men may work on several claims in the course of a year. In the vicinity of Auburn and Ophir some of the miners are occupied for a considerable part of the year in horticultural pursuits, and only mine when the work in that line is completed, but in other parts of the county the industry is exclusively mining.

SIERRA COUNTY.

The mines and mining industry of this county may be classified as follows: (1) quartz mines producing gold, distinguished as "milling propositions"; (2) drift placer mines; (3) hydraulic placer mines; (4) quartz mines bearing gold, distinguished as "pocket mines and mining"; (5) river mines of placer gold; (6) surface placer mines in the ravines and gulches; (7) tailing placers, being the reworking of the tailings from the hydraulic mines that are impounded in temporary dams. The order given is that of their relative importance in product, investment of capital, and the number of men employed.

The following is a description of the mines of this county by mining districts:

ALLEGHANY DISTRICT.—Classes 4, 2, and 1 are represented here in relative importance in the order given. Quartz mining for pockets is confined to this district. Quartz veins or lodes as a rule are narrow and irregular, and have their gold contents concentrated into small bunches of quartz of extraordinary richness, while frequently the great mass of vein matter is absolutely barren. Mining is almost entirely through tunnels, requiring no mining plant except car, track, and blacksmith shop to keep picks and drills in order. The gold-bearing quartz when found is panned by hand. The mining is almost exclusively in the hands of working miners, who have but little capital, and as a rule they keep no account of their operations, working intermittently, leaving their own mine to work for wages when they fail to find a pocket and have exhausted their means; but the aggregate results of this class of mining are satisfactory and the industry permanent. Drift placer mining is of steadily decreasing importance, and is confined to 2 producing mines (1 of which is an old mine being worked over for ground missed by the early miners) and to a few prospects that are as yet entirely undeveloped. Quartz mining as a milling proposition does not seem to have been a success, principally from lack of mill quartz. Only 1 mine, the Golden King, a new discovery operating an arrastre, is being worked at the present time, and there is no indication of the opening of other mines.

BRANDY CITY DISTRICT.—The mining industry of this district has been exclusively placer, worked by the hydraulic method, and the 2 mines which comprised all the hydraulic mining ground are now considered worked out. There is a small amount of prospecting going on for drift mines, but no developments as yet.

DOWNIEVILLE DISTRICT.—The town of Downieville is the supply point and most accessible post office for a number of widely scattered mines. The district, if it can be so called, has no distinctive class of mining, all classes except the quartz pocket mines being represented. Probably in annual yield and in the number of men employed drift placer mining is in the lead. It is the center for most of the river bed and bar mining in the county. 1 quartz mine is producing and a number are being prospected. Drift mines and quartz mines are pretty generally in the hands of incorporated companies, or of men with whom mining is not their immediate occupation, consequently fairly accurate and complete records of operations are kept. River mining is entirely in the hands of the Chinese, and but little reliable information can be obtained of their operations. Personal observation and investigation satisfied the agent that there were about 100 Chinese employed in river mining on the North Yuba river, which flows by the town of Downieville, scattered, in about a dozen companies, 10 miles each way from the town. The average time worked each year is 120 days, in 1889 probably 150, and the aggregate product between $35,000 and $45,000 annually. About half of this is sold at the bank of Messrs. Scammon & Co., at Downieville; the other half to a Chinese buyer in the same town or taken direct to San Francisco. The aggregate amount of capital invested by the Chinese in their operations is not more than $25,000. The plant consists of temporary dams in the river, one or more water wheels, and Chinese rotary pumps, derricks, ditches, and sluices to each claim. There is considerable surface placer mining in this district, though comparatively little of it is a regular occupation.

EUREKA NORTH DISTRICT.—The mines of this district are nearly all hydraulic placers, considered worked out, except 2, which are enjoined, and 1 undeveloped drift prospect.

FOREST DISTRICT.—This includes that portion of the county lying between Mountain House, in Sierra county, and Camptonville, in Yuba county, the latter being the usual post-office address. Its mining is almost exclusively confined to small drift mines and shallow placers. The total annual product is comparatively insignificant, and there are no developments being made which indicate any extension of the industry.

FOREST CITY DISTRICT.—This district 10 years ago was the locality of the most extensive and profitable drift mines in the state of California, but all the once rich mines are now practically worked out and most of the mining ground in the district has been prospected, so that there is no probability of new discoveries bringing the district up to its former importance.

GOODYEARS BAR DISTRICT.—This district is practically exhausted, only a few shallow placers being worked, with indifferent results.

GIBSONVILLE DISTRICT.—This is the leading drift placer mining district of the county, and contains also large areas of unworked hydraulic placers, with excellent water facilities and supplies; but this class of mining at this point has been stopped by injunctions.

The district next to Sierra City seemed to be in a more prosperous condition than any other in the county and to have better prospects for the future in the results of prospecting operations now under way.

GOLD LAKE DISTRICT.—This district contains some extremely profitable placers, worked by the hydraulic method, and some promising quartz mines. The placers are shallow and free washing, and very little plant and capital is required for mining. The gold is very coarse.

PIKE CITY DISTRICT.—At present there is only 1 operating mine in this district, and its future is not promising. Its importance came from the Alaska quartz mine, a large and at one time very profitable property, but now practically abandoned on account of the immense quantity of water in the deeper workings.

POKER FLAT DISTRICT.—The existing mining industry of this district is placer, divided about equally between drift, hydraulic, and surface mining, all of which is carried on in a small way by individual miners and by companies of not more than 6. The mining season is short, confined, except for the drift mines, to not more than 3 or 4 months in the spring, when water from the melting snows can be had. It seems, however, to be the best district in the county for these small operations. The post office of this district is Table Rock.

PORT WINE DISTRICT.—At present the importance of this district is dependent on the developments made in 2 drift prospecting operations. There is some unworked hydraulic ground.

SCALES DISTRICT.—This is a hydraulic placer district, but the best mines are shut down by injunctions.

SIERRA CITY DISTRICT.—The industry of this district is quartz mining for gold, in which it is the leading district of Sierra county and one of the principal districts in the state of California, and will undoubtedly remain so for many years to come. The gold-bearing quartz ledges are large, permanent, with depth, and accessible for mining operations. None of them require any hoisting or pumping plant, being exploited by means of tunnels. The ore is free milling and of fair grade. The mines are operated by incorporated companies, with a large amount of capital invested.

SAINT LOUIS DISTRICT.—Formerly a leading hydraulic mining district. It is now becoming equally important by reason of its extensive and profitable drift placers. It is a prosperous mining district, and seems likely to continue so for several years to come.

TABLE ROCK DISTRICT.—This is a hydraulic and drift placer mining district. The hydraulic mines are now, however, nearly all worked out, and the future of the district is dependent on the opening of new drift mines, as the old ones, profitable for many years, are nearly exhausted.

Nowhere in the county was any accurate method found for determining the number of tons of quartz mined or milled, the figures given being guesses. Assays are not made except at one or two of the larger mines, and then only for checking the milling losses when suspected. Very seldom is any segregating of accounts made, and accounts for nearly all of the mines, where any are kept, are for the year ended June 30, and not for the calendar year. The expenditures for fitting up hydraulic mines come in the fall of the year, after which they are left until spring, when the snows begin to melt and these claims can be mined; but by early summer the water supply gives out and operations are closed down. Sometimes a few days' run of the mine is had in the fall immediately after the first rains, but the product is not taken out of the sluices.

YUBA COUNTY.

The mining industry and mines of Yuba county can be classified as follows: (1) drift gravel placer mines; (2) surface placer mines in the ravines and gulches, worked by ground sluicing and sluicing in boxes, occasionally assisted by the use of water under pressure; (3) river mining and the working over of old tailings, confined principally to the North Fork of the Yuba river and followed almost exclusively by Chinese; (4) quartz mining for gold. The order given expresses their relative importance in product.

Drift mining is confined to the old channel deposits of gravel at Smartsville, formerly worked by the hydraulic method. Its results are moderately successful, and have led to the employment of a large number of men in a locality which had been practically abandoned. There is no likelihood of any extension beyond this locality, as there are no other drift gravel deposits in the county.

Surface mining of placer ground is located in Camptonville and Brownsville districts principally. Strawberry valley district is of nearly equal importance. This industry requires practically no capital, except in the few claims where water is used under pressure on low banks of earth in the Brownsville district. It is of constantly decreasing importance as a factor in gold product, as many of the best of the placers are exhausted. Most of this mining is carried on in wet weather, when free water can be had, and the only plant used is a pick and shovel and a string of boxes a foot square in cross-section and from 50 to 100 feet long. Surface miners keep no account of ground washed or mined, either as to area or cubic measurement.

River mining is followed by not over 50 Chinese miners, working in companies of from 4 to 10. More plant is required for this than for surface mining. Derricks for handling large rocks, dams, pumps, and ditches of some permanence, in addition to the pick, shovel, and sluice boxes of the surface miner, are usually required. The claims are more permanent, but do not pay as well per day on the average as the surface mines.

Quartz mining apparently has not been successful in Yuba county, and, except at Brownsville, there is small prospect for this branch of the gold-mining industry.

The large drift mining companies and one or two of the quartz mines keep books. The accounts of 2 of the mines at Smartville have been included in the accounts of mercantile business, which occasions some complication and explains the indefiniteness of the schedules. The other miners as a rule keep no books or permanent memoranda of the time and cost of work, or even of the gold product, usually selling the latter to the storekeepers in small amounts as taken out. In most cases they are utterly unable to give close figures regarding their operations, which are so insignificant and subordinate to other occupations that they should not properly be considered individually, but by the product obtained from parties who purchase it. They do not always sell to the same storekeeper, changing from one to another as their convenience or the difference of a few cents in the price paid per ounce influences them. It is safe to say that 70 per cent of the product of these surface mines worked by whites and Chinese is sold to the storekeepers. About half of the balance goes to the banks at Oroville, in Butte county, and Marysville, in Yuba county, and from them to the San Francisco mint or assay offices. The other half is sent direct by the producers to the mint or assay offices, in order, usually, to ascertain whether the local storekeepers pay a fair price for it. The Chinese who mine the rivers and old tailings are very secretive concerning the product, and are seldom permanent in their occupation of any particular place on the river, or even of the same river from year to year. It is practically impossible to get directly at any details of their operations or product. The best indications are in their mode of living. If their mining is paying they indulge very freely in fresh pork and poultry. From the result of investigations it is believed that about half of their gold product goes to the local storekeepers, and the balance in about equal parts finds its way to the banks at Oroville and Marysville and by express or registered mail to Chinese firms in San Francisco. The storekeepers who buy the gold do not generally consider the product a factor in their business, but generally keep a record showing the date of purchases, names, and amounts. Most of them are also informed of the particular locality whence the gold comes.

In obtaining figures of gold purchased by storekeepers care has been taken to avoid any duplication of product by omitting any amount purchased from individual mines making reports.

The quartz miners do not make fire assays of their ore, but try it in a mill or arrastre. The more pretentious mines may have an assay of the tailings made if they have any reason to suspect a loss in them.

None of the miners pay any attention to the amount of silver in the product. It is all sold as gold.

COLORADO.

The following report is furnished by Mr. Frederic F. Chisolm, special agent:

Colorado has rapidly advanced to the first place on the list of states as a precious metal producer, and this chiefly by its silver output, which now far exceeds that of any other state and nearly equals that of Nevada when the great Comstock lode was at its best. As a gold producer Colorado ranks next to California and but little ahead of Montana, Nevada, and South Dakota. The precious metal output of Colorado has received great impetus from the rapid extension of the railroad system, and promises to increase to still larger proportions, though the possibilities of Idaho, Montana, New Mexico, Oregon, and South Dakota are perhaps proportionately greater, because they have done so much, especially in silver production, in so short a time and with such inadequate transportation facilities.

During the year under review the mining industries of the state were in a flourishing condition, and the production of gold and silver for the year was the largest in its history. One noteworthy feature of mining in Colorado has been the marked increase in the number of profitable mines worked either by individuals or partnerships, but not under stock organizations. At the same time mining operations have been more under the control of men skilled in practical methods of mining than in the past, and the industry has consequently settled down more to a sound and business-like basis, from which a steady and healthy growth is assured for the future. Another gratifying feature is that the output comes from a very large number of producers, individually of medium or even small prominence, and not from a few large mines operated by corporations and owned outside the state. There are, however, as is well known, examples of phenomenally productive properties; but the fact remains that the bulk of the yield is to be credited to the mines of moderate production, which are owned and worked by citizens of the state. The number of new corporations formed in Colorado in 1889 to operate mines was less than in any year during the past decade. To the act imposing a graded fee (according to the amount of nominal capitalization) for the recording of the incorporation papers of stock companies may be fairly attributed much of the falling off in the mining stock companies incorporated under the state laws.

The extension of the railway systems has had much to do with the progress in mining. There are still many outlying districts which thus far have been handicapped by high freight tolls, but it is hoped and expected that in the near future they will be rendered more accessible. Some of these districts are giving great promise that with the increase of transportation facilities and the resulting decrease in the cost of marketing the ores the growth in the production of the precious metals in Colorado will be marked, and that the progress of this industry will fully keep pace with the great extension of allied interests in the state.

By far the greater portion of the ores of Colorado are reduced by silver-lead smelting in water-jacket furnaces. This is largely due to the remarkable metallurgical skill shown in decreasing the loss in smelting by lowering the percentage of lead required and by the unusual economy with which the process is here carried on. Of late there has been a larger use of calcining and reverberatory furnaces for the preliminary treatment of refractory ores to be smelted. The ores are not reduced at the mines, but are shipped either as crude run of mine or are concentrated at the point of production and the concentrates sent to the custom smelting works. Even where the ores are "dry" (that is, containing a low percentage of lead, or none) they are usually shipped to the smelters for mixture with other ores, with better metallurgical and commercial results than if they were treated by the amalgamation or lixiviation processes. This practice of shipping and selling ores or concentrates instead of working them on the spot is due to the almost invariable lack of success following all attempts to operate silver-lead furnaces on the ores of single mines or districts; also to the habit of selling the ores through public sampling works, which practically conduct a commission and brokerage business by correctly ascertaining the value of the shipments and selling the lots to the highest bidder. This system has been especially advantageous to the smaller mines, as it obviates the cost of erecting reduction works and affords immediate cash returns for the product. A number of large and well-equipped smelting plants have been established in Colorado, the principal centers being at Denver, Durango, Leadville, and Pueblo. These works buy ores from all quarters and draw also upon districts outside the state. By the preliminary admixture in beds of various ores in order to secure as nearly as possible a typical smelting ore they are enabled to operate to the best advantage and handle large quantities of ores which could not be profitably treated by themselves.

Silver amalgamating mills and leaching works are not in vogue in Colorado, where the conditions, as just stated, are more favorable to the smelting process. There are, however, a number of amalgamating mills for working free-gold ores. The treatment of such ores by crushing, either by stamps, rolls, or centrifugal mills, is carried on to a large extent in Gilpin county, where the ores are practically all auriferous sulphides, in which the uncombined gold readily amalgamates. Battery amalgamation is relied on to a larger degree than is customary in other districts.

Concentration of the smelting ores before shipment is becoming more general, a large number of custom concentrating plants being now in successful operation. These enable large quantities of low-grade ores to be utilized, which in the crude state could not meet the expense of transportation. The desirability of the sulphides of iron and of iron and copper in the process of calcining in reverberatory matte furnaces has led to a great increase in concentration, after amalgamation, of the pyritous ores, especially of Gilpin county.

Placer mining in Colorado, as elsewhere in the United States, is decreasing, and more attention is being paid to lode deposits. In this state, indeed, placer mining has never been of very great importance since the remarkable success in lode mining. There are, however, many small placers, some of them rich, which will continue to yield their quota for years to come. There are also some placer deposits which have not yet been worked for want of water. These latter may be brought into operation in the future.

Only a small portion of the base bullion produced by the silver-lead furnaces is refined in Colorado, although a great part of the bullion shipments goes to a refinery which is practically a branch of one of the largest Colorado smelting works.

The leading counties in point of production of gold and silver are Lake (in which is the Leadville district), Pitkin (containing the Aspen and other flourishing districts), and Clear Creek. Gilpin, Ouray, Summit, San Juan, and San Miguel counties also contribute largely. The list of counties which produce more or less gold and silver is a a long one, and besides the productive counties there are others which have not yet been thoroughly prospected, and which in time will probably be added to the number. Briefly, the condition of precious metal mining in Colorado during 1889, in the several counties which take rank as distinctively mining regions, is indicated in the following notes:

BOULDER COUNTY.

This county contains what is practically the northernmost end of the mineral belt, though there are a few outlying districts of minor importance still farther north. The ore is principally free-milling and sulphuret gold quartz, which is treated by local mills, which extract the free gold and concentrate the auriferous sulphurets, the concentrates being sent to the smelters. There is also some silver smelting ore produced, which is shipped to one of the large smelting establishments in the state, as there are no smelters in the county. A very little placer mining is being done.

CHAFFEE COUNTY.

There is considerable placer mining (on a small scale individually) along the Arkansas river, but the main reliance of the county is on lode mining. The ores are of 2 classes—free-gold quartz (of which the production is comparatively small) and smelting ores. These latter are shipped principally to Leadville, Denver, and Pueblo.

CLEAR CREEK COUNTY.

This is the third in point of production of the gold and silver mining counties of Colorado, its output being $3,000,000 and upward annually. The ores are mainly silver-lead smelting ores. Most of the camps are of long standing, but the Ute district entered on a large production for the first time in 1889. There is but little placer mining in the county.

CONEJOS COUNTY.

Active operations were resumed in 1889 in several of the old districts, in which nothing had been done for years, making Conejos practically a new mining field.

COSTILLA COUNTY.

The mining territory in this county is mostly held under the Costilla land grant. An insignificant amount of work is being done in the neighborhood of Culebra.

CUSTER COUNTY.

This is an old mining region. There were no important new developments during the year. Mining is confined to the lode deposits, which yield smelting ores, all of which, ore and concentrates, are shipped out of the county for treatment.

DOLORES COUNTY.

A little placer mining is being done on Disappointment creek. The principal lode mines are at Rico. They produce silver-lead smelting ores, all of which are shipped to outside reduction works.

EAGLE COUNTY.

This county contains silver-lead ores in a limestone formation very similar to that of Leadville, Lake county. There are also peculiar gold ores occurring in caves in quartzite. Both kinds of ore are shipped out of the county for treatment.

FREMONT COUNTY.

This county has not yet attained prominence as a precious metal producer. Mining is confined to lode deposits, which are worked on a small scale.

GARFIELD COUNTY.

There was practically no mining in this county in 1889. The results of operations in the past have not been sufficiently encouraging to lead to a thorough prospecting of the region, so that its capabilities remain to be determined.

GILPIN COUNTY.

The oldest mining camps of Colorado are found in Gilpin county, and productions still continue to be steady and reliable. The ores are principally free-milling gold quartz, which are treated in local mills, and after amalgamation are concentrated, the concentrates (auriferous sulphurets) being sold to the smelters. Much placer mining is carried on in the county. There is also a small output of silver-lead smelting ore, which is shipped. Large operations are prosecuted at Bald Mountain, Black Hawk, Central City, Nevada, Rollinsville, and Russell.

GUNNISON COUNTY.

This county covers a large area and contains many mineral deposits. There is a little placer mining near Tin Cup, but the principal operations are on the lodes. The ore is generally found in fissure veins, except at Tomichi and White river, where silver-lead deposits are met. An interesting development of gold ores at Tin Cup was made during the year 1889.

HINSDALE COUNTY.

Mining in Hinsdale county was greatly retarded in former years by insufficiency of transportation facilities. In 1889, however, a branch of the Denver and Rio Grande system was extended into the county. The mines, which are all on lode deposits, ship their products out of the county for reduction.

HUERFANO COUNTY.

Mining is carried on to a slight extent in the neighborhood of Gardner, Malachite, and Sharpsdale. The output is small. There are some placers in the county, which, however, are not at present worked.

LAKE COUNTY.

Lake county contains the famous Leadville district, which has been so often described as to make its character generally known. The ores are of the silver-lead smelting class, occurring on contacts of limestone with the overlying porphyry. During the year some very interesting developments were made immediately under the town of Leadville. It has been proved that the great ore bodies extend much farther than was formerly believed. These explorations have resulted in heavy shipments from the new ore-bearing territory in 1890. While the average grade of the Leadville ores is lower than formerly and the annual aggregate output in bullion is less, the ore tonnage was greater in 1889 than at any previous time in the history of the district. Toward the close of 1889 work was resumed in the old Homestake district.

LA PLATA COUNTY.

This county contains several mining camps, though the output thus far is not large. The deposits are believed to be of great value, but the country is extremely inaccessible. Mining is confined to the lodes. The ores are refractory, and are mostly smelted at Durango, in the county.

LARIMER COUNTY.

There are a number of promising gold properties at Manhattan, but owing to the inaccessibility of the region the output in 1889 was small.

OURAY COUNTY.

Ouray county is an important source of the precious metals. The ore occurs in fissure veins traversing various eruptive rocks. It is all shipped out of the county, either as crude ore or as concentrates. Mining is confined to lodes. The leading districts are Ouray and Red Mountain. At the latter place there was greatly increased activity in 1889, and, indeed, throughout the county great progress is being made.

PARK COUNTY.

This county is one of the oldest mining regions in the state, and contains both lode and placer mines. The latter are of considerable value, but were not largely worked in 1889. No new developments of importance were made during the year.

PITKIN COUNTY.

Pitkin county is the second largest producing county in Colorado, and furnished a largely increased output in 1889. The ores are smelted and are generally "dry", although an unusually large proportion of the ore mined in that year carried lead in notable quantity. The principal camp is Aspen. Ashcroft district contains promising deposits, but has suffered from need of transportation facilities, and developments there are waiting for railroad connections to be made. A marked increase in mining and in production occurred in Tourtelotte Park in 1889, and very flattering developments have been made on Maroon creek, as well as on Frying Pan, Hunter, and Woody creeks. In these last 3 localities explorations seem to indicate that the ore-bearing contact of Aspen has been found.

RIO GRANDE COUNTY.

The operations in this county are confined to lode mining. There was a comparatively small production in 1889, owing to various causes. A considerable proportion of the ore is free-milling gold quartz; the remainder is smelting ore, which is sold and shipped away for reduction.

ROUTT COUNTY.

A small output of gold came from the Hahns Peak placers in 1889. In the same region there are also a number of promising free-gold lode claims.

SAGUACHE COUNTY.

This county is extremely inaccessible, and for this reason mining operations have heretofore been on a small scale. The lodes only are worked. The ore is of the smelting class, but is very refractory.

SAN JUAN COUNTY.

San Juan county is one of the important producers, containing a number of free-gold mines, which were worked on a large scale during the year. There are also important deposits of mixed sulphide smelting ores in fissure veins. Mining is confined to the lodes.

SAN MIGUEL COUNTY.

Both placer and lode mining is carried on in this county. The Marshall Basin mines (smelting ores) produced largely during the year, and renewed activity was manifested at Ophir, one of the oldest camps in the state. All of the smelting ores are shipped out of thé county.

SUMMIT COUNTY.

Summit county also is a large producer, containing a very large number of mines, both lodes and placers, but the greater part of the output comes from the many small mines of silver-lead ores. Mining has been carried on in this county without much change for many years, Summit being one of the first mining counties in the state to be opened.

CONNECTICUT.

New England does not appear as a factor in the production of either gold or silver in the year 1889, and only one state, Connecticut, shows any operation. In Hartford county a considerable amount of work was done in the way of redeveloping an abandoned mine. In the prosecution of this work expenses to the amount of $17,738 were incurred, as follows:

DISTRIBUTION OF EXPENDITURES IN GOLD MINING IN CONNECTICUT.

Paid for wages	$10,036
Paid for supplies	3,977
Other expenditures	3,725
Total	17,738

NEW MEXICO.

The following is an abstract of a report made to the United States mint by Mr. Walter C. Hadley:

New Mexico has been but slightly explored by prospectors for the precious metals. Practically only 1 railroad penetrates those portions where gold, silver, lead, or copper has been found in marketable quantities, and only 2 other railroads traverse sections where ores of value may be expected. One of the latter transported last year but 65 tons of ore from points within the territory, and the other carried ores from only 2 shipping points in New Mexico, and those in very inconsiderable amounts. In other words, it may be said that 1 railroad carried all the ores and bullion produced by the territory, and of its total mileage within the territory about 11 per cent is in short branches from the main line, which have been constructed to facilitate ore shipments. Many promising discoveries have been made at points where active operations may be expected when railroad facilities reach them. Only a general review of the production by counties is given.

COLFAX COUNTY.

The output of gold for a number of years from the placers and quartz ledges of Colfax county, particularly of the Ute Creek and Elizabethtown districts, has been considerable, and in some years quite large.

DONNA ANA COUNTY.

The Organ mountains chiefly furnished the precious metals produced in this county in 1889, the silver-lead mines being the ones most actively worked. The gold output was unimportant. There are no local works for the treatment of ores, which are hauled to Las Cruces for railroad transportation.

GRANT COUNTY.

The first discovery of the precious metals in Grant county was made in May, 1860, when gold was found in both gravel and ledge at Pinos Altos. 10 years later silver mines near Silver City began to be worked, and for 25 years the county has been more reliable and constant in production than any other in New Mexico. Sierra county has in certain years surpassed it, but development work there has neither been so widely extended nor so unremittingly prosecuted. In both counties it is noticeable that the most valuable silver mines are in contact veins, with lime for one wall and either lime, slate, or porphyry for the other. It is also noticeable that the best gold veins are fissures, chiefly in syenite. There are a few silver-lead fissure veins of great promise. The óre is free-milling, and all the lower grades are treated by amalgamation at the local mills. Pinos Altos led as a gold producer. The principal mines have also their own mills, wherein the ores are treated by amalgamation and concentration. The concentrates are shipped to smelters in Socorro, New Mexico, or Denver, Colorado. As yet a high percentage of saving has not been attained by some of the mill men.

Many engaged in the mining of the precious metals are incapable of correctly estimating the cost of producing a ton of ore. Those who have had only limited experience rarely place the cost at more than $4. Of course, large bodies of low-grade gold ores and lead carbonate ores may be found that can be mined at this or a much lower figure. Miners of more extended experience, however, put the cost of mining from the average vein at from $15 to $25 per ton. It is believed, however, that the average cost is not much more nor less than $30 per ton for every ton of ore mined in New Mexico, and the mines of New Mexico are not different from those of Colorado or Montana.

LINCOLN COUNTY.

Since 1879 gold has been produced in White Oaks, and discoveries of gold in other parts of the county have been made. A large amount of money was squandered by eastern operators, who undertook to introduce novel methods. Within the past 2 or 3 years experienced miners and mill men have taken hold of the White Oak mines and attained success.

SANTA FE COUNTY.

Recent discoveries of silver-bearing lead carbonates near San Pedro are important. During 1889 the output therefrom was about 4,000 tons, containing gold, $6,520; lead, $52,430, and silver $77,310. More than three-fourths of this amount was taken from the Lincoln Lucky mine.

SIERRA COUNTY.

The only rival Sierra county has in the production of the precious metals is Grant county. The mines of the latter, however, were productive for many years before those of Sierra were discovered. There is a larger proportion of mountainous country in Sierra than in any other county in New Mexico, and mining is the chief occupation of its people. At Lake Valley there is a leaching mill and an amalgamating mill, with joint capacity of 100 tons per day. Neither is in operation. All ore is shipped, as it is in demand with smelters for fluxing purposes. A 20-stamp gold mill is in operation at Hillsboro. Hermosa has a concentrator, Chloride a leaching mill, and Kingston a concentrator. Other producing districts are Animas, Chloride, North Percha, South Percha, and Tierra Blanca.

SOCORRO COUNTY.

During the year Socorro county became prominent as a gold producer. The new discoveries were in the Mogollon mountains, where 2 stamp mills have been in operation, one at Cooney and the other on Silver creek. The prospects for increased production in this section are promising. Other producing camps furnished chiefly silver-lead ores of excellent fluxing qualities, which have made Socorro a smelting center. A new smelter was erected at Kelly Camp last winter, but it is not yet in operation.

SMELTING WORKS.—The only custom smelting works in practical operation in New Mexico during the year 1889 were those of the Rio Grande Smelting Company, at Socorro. The product, as base bullion, was shipped to the Saint Louis Smelting and Refining Company. Arizona, Mexico, and New Mexico furnished almost all of the ores treated. There are in the territory smelters at Albuquerque, Carlisle, Deming, Kelly, Kingston, Las Cruces, Silver City, and Socorro, all of them idle.

WYOMING.

The following report is furnished by Mr. John W. Burkhardt, special agent:

The Miners Delight mines, in the Sweetwater country, Fremont county, consist of 5 mines, but only 2 have been developed. This group of mines, as well as those in Atlantic City and South Pass, all lie in a hard blue porphyritic slate in veins from 16 inches to 8 feet wide, with a greenish wall on each side. The quartz is sometimes bluish, again it is feldspathic, with free gold disseminated through it and plainly visible to the naked eye; but most of these leads also contain zinc, antimony, tellurium, arsenical iron, traces of tin, etc., which consequently make the ore in general refractory. Atlantic City, Miners Delight, and South Pass are only 4 miles distant from each other, and all the mines are in the foothills nearest the prairie. The main range, where the best mines ought to be situated, has not as yet been prospected. The foothill mines have been very rich pocket mines; in fact, several thousand dollars were pounded out in hand mortars.

Miners Delight has 3 quartz mills of the pattern of 1858. These were in operation only a short time, and the principal reason that these mines were abandoned at so early a stage of their development was the reckless waste of large sums of money. The capitalists who furnished the money, being disinclined to come out to what was then a wild country infested with hostile Indians, left the whole management of the mines to persons whom they employed. The investors, receiving no returns, presumed that the mines were valueless, and therefore had them closed down; and there is not up to this date a shaft 200 feet deep either at Atlantic City, Miners Delight, or South Pass. The ore of most of the mines assays in bulk from $9.50 to $180, and will average, with moderate concentration, from $6 to $14 per ton throughout the camp. All machinery could be driven by water power, but the mines lie in the foothills. As it now stands, it is merely a rich specimen country. Recently two boys discovered a lead about 500 feet south from the old Buckeye lode, with ore assaying from $23 to $40 per ton. The vein is about 20 inches wide, and the rich quartz came out of a pocket in it. These mines, and, strange to say, every mining district of any note in Wyoming, are situated on the southeast side of the mountains. There are 2 districts, about 12 miles apart, the Seminoe and the Ferris. Seminoe, the most southern mountain, nearest to the Platte river, lies about 40 miles north of Rawlins, and has free-gold bearing veins, and formerly had a 10-stamp mill running, but as fuel was scarce and the mine in litigation it was closed down, although development work is still going on. In the Ferris district the leads are principally silver-bearing low-grade galena, oxide of iron, and sulphide of iron.

NONPRODUCING STATES.

Letters were sent to the state geologists or other officials in the states not included in the list of states and territories producing the precious metals, with a view of learning, if possible, whether any recent discoveries of gold and silver had been made in these states in recent years. The following are abstracts from the replies received:

MAINE.

Gold is reported to have been found in the sand of a stream called Sandy river, in the northern part of Franklin county. A stock company has been organized to mine it, but no statistics of production have been obtained.

VERMONT.

The state geologist says that no mines of gold and silver are being worked in the state at present.

NEW JERSEY.

The state geologist states that he knows of no gold or silver mines in the state.

TENNESSEE.

The state geologist reports that he doubts very much whether any silver has been produced in the state during the last year, or, for that matter, at any time in the past. In former years, and especially before the war, some gold was obtained at points in Tennessee adjoining the North Carolina line. A little gold is found in Blount, Cocke, Monroe, and Polk counties.

FLORIDA.

The commissioner of agriculture writes that there are no deposits of gold or silver known to exist in this state. Some "finds" have been reported in Marion county, but he can not vouch for the truth of the reports.

KENTUCKY.

The assistant in charge of the geological survey reports that there are no mines of either gold or silver in Kentucky.

ILLINOIS.

The state geologist says no gold or silver is produced in the state, although both metals are known to exist in the lead ores of Hardin county and have also been found occasionally in the drift gravels of other counties.

MINNESOTA.

The state geologist reports that there is no gold or silver mining within the state of Minnesota.

MISSOURI.

The state geologist reports that several mines have been opened in the state in search of gold and silver, but have, for the most part, been abandoned. None of the mines have ever paid expenses, though some of them contain fine silver ore in very small amounts. Besides these there are many worthless gold mines, in which more or less money has been spent.

THE INFLUENCES WHICH AFFECT THE PRODUCTION AND RELATIVE VALUES OF GOLD AND SILVER.

Gold, being coined free, is independent of market quotations, and its output depends solely upon the cost of production, where not restricted by legal enactment, as is now the case in California. In periods of mining excitement, or "booms", induced generally by the discovery of exceptionally rich deposits, the investment of capital in developing mines and in working unprofitable properties adds somewhat to the normal output, but since the greater part of the gold is now produced from regular, as opposed to intermittent, mining enterprises, the effect of booms on the production of the precious metals is not very marked. Their chief influence is felt at a later period, for a mining excitement generally results in the discovery of some mines that later on become regular and profitable producers. The discovery of the rich placer deposits of California in 1848 quickly increased the gold product from insignificant proportions to $50,000,000 in 1850, $60,000,000 in 1852, and to the highest figure it has ever reached, namely, $65,000,000, in 1853. Placer gold, even where found over such an enormous area as in California, is worked out in a comparatively short time, and the statistics quoted in this report show that the gold production rapidly declined after 1853, notwithstanding the vast number of people attracted to mining by the fabulous profits earned by the few fortunate ones. In 1862 the product had declined to $39,200,000, but the discovery of other washings, and particularly of the great Comstock lode in Nevada shortly after that, began to be felt. This district in 1862 produced $2,500,000 of gold and silver, and has since added so enormously to the precious metal supplies that it sustained the gold product, notwithstanding the heavy decline in the output of the hydraulic mines of California. The Comstock district continued to increase until 1876, when it reached its maximum of $38,000,000 in one year, of which about $16,000,000 was gold and $22,000,000 silver. In all, since 1860, this great deposit has produced no less than $320,000,000, of which about $125,000,000 was gold and $195,000,000 silver. Notwithstanding this enormous addition to the gold product, the total annual gold yield of this country has declined since 1853, though it recovered somewhat its lost ground in the years 1865 to 1870, when it reached again above the $50,000,000 mark. Since then it has gone as low as $30,000,000, in 1883, and has since then increased but very little.

The chief reasons for this decline in the production are to be found in the working out of the auriferous gravel deposits in various parts of the country, and in California legislation, which since 1882 has practically prohibited hydraulic mining and has been the chief cause in bringing the output of that state down from $17,000,000 in 1882 to $12,586,722 in 1889. The decline in the Comstock has already been referred to as the cause of a heavy decline in the Nevada gold product from more than $19,000,000 in 1878 to about $3,500,000 a year at the present time. Most of the states which are small or moderate producers are increasing slightly and steadily, but this is far from compensating for the heavy losses in California and Nevada.

Whether the production of gold in the future will increase or diminish is a very important question, which a mere study of these statistics of the metal can not solve. It is certain that the repeal of the antidébris legislation in California would add very largely to the gold output of that state, but aside from this there is no apparent prospect of any rapid increase in gold production. It is of course possible that some new auriferous gravel deposits may be found or worked and that some great gold-bearing bonanza, like the Comstock, may be discovered, but so far as present knowledge goes the gold production of the future will come in constantly increasing proportion from the treatment of gold-bearing ores and less and less from gravel mines; in other words, gold production in the future will be more and more from permanent and but slightly fluctuating sources and less and less from great "finds". Whether the certain but rather slow growth of the output from the treatment of ores will more than compensate for the equally certain gradual lessening quantity produced from placers can not, of course, be foretold, but the fact that the production of gold in recent years has not only ceased to decline, but has even increased slightly, seems to indicate that this country will be at least able to maintain and will probably gradually increase the output of this indispensable metal.

The immense progress made in metallurgy in recent years has permitted the extraction of the gold from many ores which were formerly of too low grade to pay for treatment. Unouestionably this progress will continue and in time very important amounts will be added to the yearly output.

The production of gold and silver in the United States is coming more and more from the treatment of the gold-bearing ores of other metals and less from strictly gold and silver ores. The industry is becoming year by year more of a regular nonspeculative manufacturing business, in which great "finds" and bonanzas have less and less influence, and it is therefore certain to increase with a steady and healthy growth. Investments in precious metal mines still continue to be made as "gambles", and consequently are still, on the whole, unprofitable; but every year diminishes this unhealthy characteristic of mining, and brings the industry more into the category of legitimate industrial enterprises, where investments are made with the same precautions as in other classes of business, and moderate profits are sought as the reward of steady industry, while the class of "millionaires of a day" is disappearing. At the present time about 134,000 tons, or 72 per cent, of the entire output of lead is silver-bearing or silver and gold bearing, and is "desilverized" before marketing, while nearly all the copper produced in Montana, amounting in 1889 to about 100,000,000 pounds, and nearly all that mined in California, Colorado, Nevada, Utah, and other western states, except in some of the Arizona copper mines, carries silver and gold. It has not been possible to ascertain exactly the amount of gold and silver that has come from the treatment (for the most part the smelting) of copper and of lead ores.

The progress in metallurgy is, however, adding still more rapidly to the production of silver than to that of gold; so that while the output of gold will probably increase in the future, that of silver, a much more abundant metal in nature, will undoubtedly increase still more rapidly. Nearly every improvement which tends to reduce the cost of production, whether it be an improvement in metallurgical processes, which enables the extraction of a larger proportion of the metal from its ores or to extract it at less cost, whether it be the building of railroads, which reduces the cost of transportation of the machinery and supplies used at the mines and with these reduces the cost of labor, nearly everything, in fact, that tends to make gold more abundant, increases in a still greater degree the production of silver. Hence it is evident that the relative value of gold as compared with silver will continue to increase unless free coinage is given to both metals and some international agreement is established fixing the relative value of the metals independent of their abundance.

The following table gives the proportions by weight and by United States coining values (16 to 1) at which the two metals have been produced in the United States and in the whole world since 1850. Further discussion of the the world's statistics will be found on the following page.

PROPORTIONS IN WHICH GOLD AND SILVER HAVE BEEN PRODUCED.

YEARS.	UNITED STATES. By weight.		THE WORLD. By weight.		THE WORLD. By United States coining value.	
	Gold.	*Silver.*	*Gold.*	*Silver.*	*Gold.*	*Silver.*
1850	1 to	0.016	1 to	16.00	1 to	$1.000
1860	1 to	0.032	1 to	5.47	1 to	0.345
1870	1 to	5.120	1 to	5.79	1 to	0.485
1880	1 to	17.440	1 to	14.20	1 to	0.890
1889	1 to	32.320	1 to	21.92	1 to	1.370

The chief influences which in the future will affect the production of the precious metals, and which will always be more potent in increasing that of silver than that of gold, are improvements in metallurgical processes which will permit of extracting the metals from lower and lower grade ores. It is safe to assume that ores will always be worked down to the limit where the market value of the metal produced ceases to pay for its extraction. Fluctuations in the market value are rather the consequences than the causes of fluctuations in the amount produced.

COST OF PRODUCING GOLD AND SILVER.

The actual cost of production of the precious metals varies so greatly at different mines and works that it would be impossible to arrive at any absolutely accurate average. That one of the great gold or silver mines, when in bonanza, earns enormous profits merely means that the cost of production is but a small part of the market value of the metal produced. But the mirage of the widely known, if not long, list of millions accumulated by fortunate owners of gold and silver bonanzas induces the investment of millions in the opening and working of prospective bonanzas that never materialize, and encourages and supports the lonely prospector in his wearisome waiting for the fortune that never comes. The spirit of the gambler controls in great measure investments in precious metal mines, and so far as this class of investment goes there can be no doubt that it is, on the whole, unprofitable, or, in other words, that the gold and silver obtained by it cost much more than they are worth in the market.

When the enormous amounts of money actually invested in unprofitable mines and mills are considered, some of which are strictly legitimate and honest, while some have been "salted" or sold on false representations, it is easy to recognize the heavy offset to the great profits of the few large producers and to believe that the average cost of all the gold produced is more than $20.67 per ounce troy, and that of silver is more than, say, $1 per troy ounce. In gold and silver mining, as in buying lottery tickets or in playing on the gaming table, it is the chance of winning a prize that induces people to put their money into what is, on the average, an unprofitable investment. Moreover, the money invested in mining comes back to some of the investors or to the promoters and inducers of investment in many other forms, such as through the furnishing, at large profit, of supplies to the miners, or in the advance in the value of property in the vicinity, or in building up a town, or in some other way that can not be directly credited to the mine. Thus it is that while gold and silver mining on the whole may have been unprofitable to those who have without proper and reasonable precautions invested capital in them, there can be no question whatever that this great industry has been enormously advantageous to the country at large. It has created in the western states and territories a vast empire, has developed many other industries, and brought unexampled prosperity and a vast population. The industry deserves and should receive every consideration which the laws of the country can afford. Nor is gold and silver mining on the average necessarily unprofitable. With the exercise of ordinary care and prudence gold and silver mining becomes one of the most profitable industries in which capital can invest; but unfortunately a majority of those who invest in it do so, as they make bets on horse races, without any knowledge to justify the investment.

THE WORLD'S PRODUCTION OF GOLD AND SILVER.

In order to appreciate the importance of the gold and silver production of the United States it is necessary to make comparison with that of the world, and to do this intelligently it is imperative to investigate the differing statistics of the world's production and to deduce from all the data available the most probable figures. The accompanying diagrams, showing the production and relative values of the two metals and the study of the decline in the price of silver, will greatly assist in comprehending this subject.

The accompanying table, credited to Dr. Adolph Soetbeer's "Materials toward the elucidation of the economic conditions affecting the precious metals", is taken from the report of the British commission on recent changes in the relative value of the precious metals (1887). The accompanying diagram has been made by plotting the figures in the table representing values.

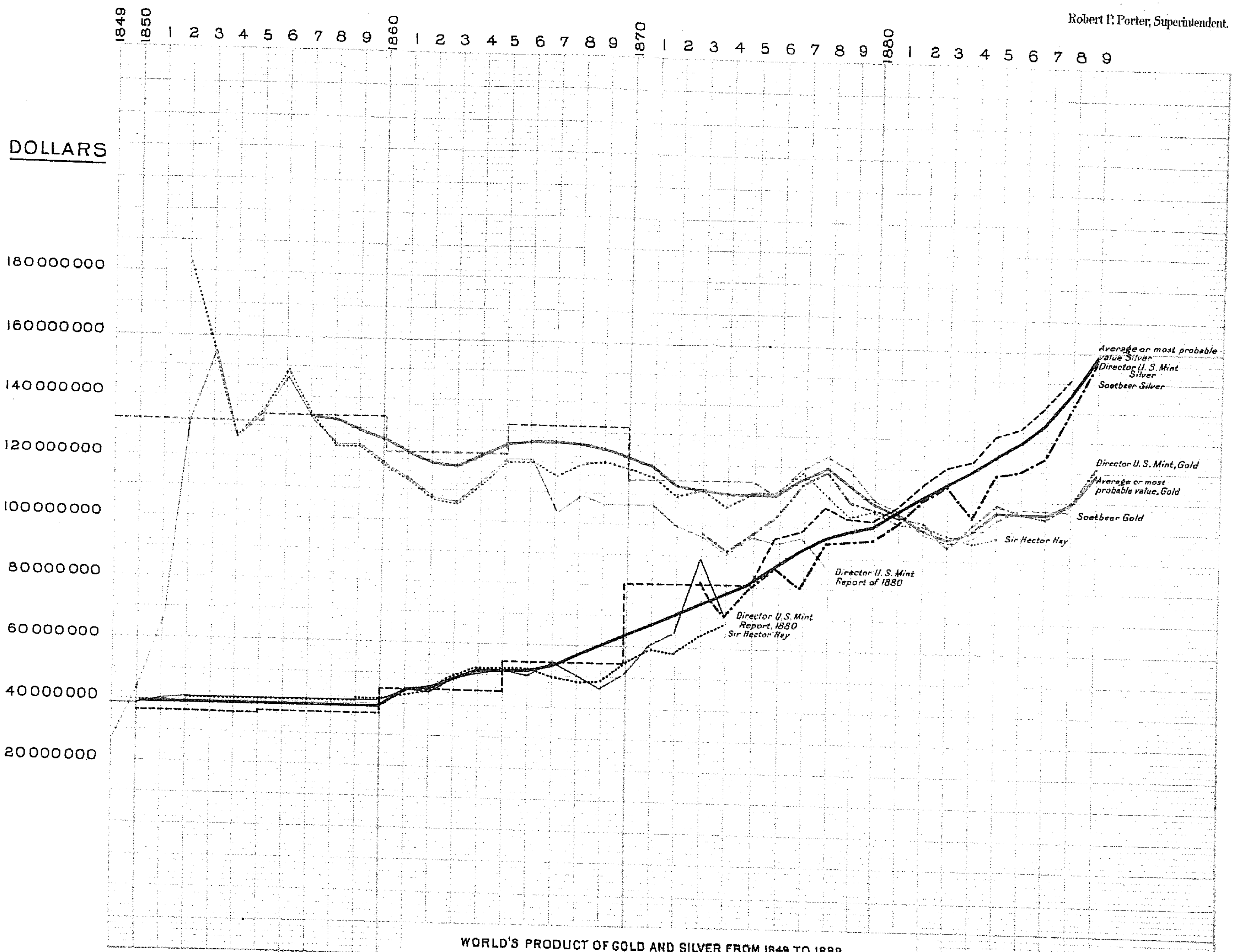
SOETBEER'S ESTIMATES OF THE PRODUCTION OF THE PRECIOUS METALS FROM 1493 TO 1885.

PERIODS (ANNUAL AVERAGE).	WEIGHT.				VALUE.					
	Gold. (Kilograms.)	Silver. (Kilograms.)	Percentage of proportion.		Gold. (Thousands of marks.)	Silver. (Thousands of marks.)	Percentage of proportion.		Gold and silver. (Thousands of marks.)	Value in gold of 1 kilogram of silver. (Marks.)
			Gold.	Silver.			Gold.	Silver.		
1493–1520	5, 800	47, 000	11. 0	89. 0	16, 182	12, 220	57. 0	43. 0	28, 402	260
1521–1544	7, 160	90, 200	7. 4	92. 6	19, 976	22, 370	47. 2	52. 8	42, 346	248
1545–1560	8, 510	311, 600	2. 7	97. 3	23, 742	76, 965	23. 6	76. 4	100, 707	247
1561–1580	6, 840	299, 500	2. 2	97. 8	19, 083	72, 779	20. 8	79. 2	91, 862	243
1581–1600	7, 380	418, 900	1. 7	98. 3	20, 590	98, 860	17. 2	82. 8	119, 450	236
1601–1620	8, 520	422, 900	2. 0	98. 0	23, 771	96, 421	19. 8	80. 2	120, 192	228
1621–1640	8, 300	393, 600	2. 1	97. 9	23, 157	78, 326	22. 8	77. 2	101, 483	199
1641–1660	8, 770	366, 300	2. 3	97. 7	24, 468	70, 330	25. 8	74. 2	94, 798	192
1661–1680	9, 260	337, 000	2. 7	97. 3	25, 835	62, 682	29. 2	70. 8	88, 517	186
1681–1700	10, 765	341, 900	3. 1	96. 9	30, 034	63, 593	32. 1	67. 9	93, 627	186
1701–1720	12, 820	355, 600	3. 5	96. 5	35, 768	65, 075	35. 5	64. 5	100, 843	183
1721–1740	19, 080	431, 200	4. 2	95. 8	53, 233	79, 772	40. 0	60. 0	133, 005	185
1741–1760	24, 610	533, 145	4. 4	95. 6	68, 662	100, 764	40. 5	59. 5	169, 426	180
1761–1780	20, 705	652, 740	3. 1	96. 9	57, 767	124, 021	31. 8	68. 2	181, 788	190
1781–1800	17, 790	879, 060	2. 0	98. 0	49, 634	162, 626	23. 4	76. 6	212, 260	185
1801–1810	17, 778	894, 150	1. 9	98. 1	49, 600	160, 053	23. 7	76. 3	209, 653	179
1811–1820	11, 445	540, 770	2. 1	97. 9	31, 932	97, 339	24. 7	75. 3	129, 271	180
1821–1830	14, 216	460, 560	3. 0	97. 0	39, 663	81, 519	32. 7	67. 3	121, 182	177
1831–1840	20, 289	596, 450	3. 3	96. 7	56, 606	105, 572	34. 9	65. 1	162, 178	177
1841–1850	54, 759	780, 415	6. 6	93. 4	152, 777	137, 353	52. 7	47. 3	290, 130	176
1851–1855	199, 388	886, 115	18. 4	81. 6	556, 308	160, 387	77. 6	22. 4	716, 695	181
1856–1860	201, 750	904, 990	18. 2	81. 8	562, 899	164, 709	77. 4	22. 6	727, 608	182
1861–1865	185, 057	1, 101, 150	14. 4	85. 6	516, 326	199, 308	72. 1	27. 9	715, 634	181
1866–1870	195, 026	1, 339, 085	12. 7	87. 3	544, 139	239, 696	69. 4	30. 6	783, 835	179
1871–1875	173, 904	1, 969, 425	8. 1	91. 9	485, 207	344, 649	58. 5	41. 5	829, 856	175
1876–1880	172, 414	2, 450, 252	6. 6	93. 4	481, 045	382, 062	55. 7	44. 3	863, 107	156
1881–1885	149, 137	2, 861, 709	5. 0	95. 0	416, 098	428, 760	49. 3	50. 7	844, 858	150

Referring to the table and the diagram, it is seen that between 1493 and 1660 the production of gold was nearly stationary. The value of the silver product increased about eightfold between 1493 and 1600, and the price of silver decreased from 260 marks per kilogram to 236 marks. During the next 60 years the silver product decreased: but the price of silver, instead of increasing, decreased much more rapidly than in the earlier period.

From 1660 to 1780 the production of silver greatly increased, then rapidly decreased to 1820, and again greatly increased to 1860. The gold product increased from 1660 to 1760, decreased to 1820, and then increased more than tenfold between 1820 and 1860. The relative value of the total production of gold and silver varied through wide ranges from 1660 to 1860. Notwithstanding these violent fluctuations in both metals, and in the relative product of each, the price of silver per kilogram remained nearly stationary during these 200 years. From 1860 to 1885 the production of gold decreased and that of silver increased, but the great decline in price of silver did not set in till 1873.

The table following shows the world's production of gold and silver from 1849 to 1889, as given by different authorities. The figures in the columns headed "Soetbeer", from 1851 to 1884, inclusive, are from Dr. Adolph Soetbeer's "Materials toward the elucidation of the economic conditions affecting the precious metals", second edition, Berlin, 1886, translated by Professor F. W. Taussig, and published in Mr. Edward Atkinson's report of bimetallism in Europe, 1887. (Executive document 34, Senate, Fiftieth Congress, first session.)



WORLD'S PRODUCT OF GOLD AND SILVER FROM 1849 TO 1889
ACCORDING TO VARIOUS AUTHORITIES.

WORLD'S PRODUCTION OF GOLD AND SILVER.

Years	Gold. (Millions of dollars.)				Silver. (Millions of dollars.)				
								Mint report, 1889.	
	Soetbeer.	Sir Hector Hay.	Mint report, 1880.	Mint report, 1889.	Soetbeer. (a)	Sir Hector Hay.	Mint report, 1880.	Commercial value.	United States coining value.
1849			27.1				39.0		
1850			44.5				39.0		
1851			67.6				40.0		
1852		182.5	132.8			40.5	40.6		
1853	b132.5	155.0	155.5		b36.8	40.5	40.6		
1854		127.0	127.5			40.5	40.6		
1855		135.0	135.1			40.5	40.6		
1856		149.5	147.6			41.0	40.7		
1857		133.3	133.3			41.0	40.7		
1858	b134.1	124.0	124.7		b37.7	41.0	40.7		
1859		124.5	124.9			41.0	40.8		
1860		119.0	119.3			41.5	40.8		
1861		114.0	113.8			43.0	44.7		
1862		107.0	107.8			45.5	45.2		
1863	b123.0	106.5	107.0		b45.8	49.5	49.2		
1864		113.0	113.0			52.0	51.7		
1865		120.0	120.2			52.5	52.0		
1866		121.0	121.1			52.0	50.8		
1867		116.0	104.0			50.5	54.2		
1868	b129.6	120.0	109.7		b55.7	49.0	50.2		
1869		121.0	106.2			49.0	47.5		
1870		119.0	106.9			55.5	51.6		
1871		116.5	107.0			59.0	61.1		
1872		110.0	99.6			58.5	65.3		
1873	b115.6	111.5	96.2	96.2	b81.9	64.0	89.3	82.1	81.8
1874		107.5	90.8	90.8		68.0	71.5	70.7	71.5
1875		110.5	97.5	97.5		69.0	80.5	77.6	80.5
1876	110.3	111.5	95.0	103.7	96.6	77.0	74.0	78.3	87.6
1877	119.3	117.0	97.0	114.0	99.3	87.0	81.0	75.2	81.0
1878	123.5	110.5	86.5	119.0	106.1	80.5	73.0	84.6	95.0
1879	119.2	104.0		109.0	104.2	79.0		83.4	96.0
1880	108.7	106.0		106.5	103.1	87.5		85.6	96.7
1881	105.6	103.0		103.0	107.8	94.0		89.8	102.0
1882	98.7	101.0		102.0	115.1	102.5		98.2	111.8
1883	96.1	98.0		95.4	120.4	103.0		99.0	115.3
1884	97.1	95.5		101.7	122.9	104.0		90.8	105.3
1885	102.7	97.5		108.4	132.0	106.5		97.6	118.5
1886	107.3			106.0	134.6			92.8	120.6
1887	106.3			105.8	141.9			94.0	124.3
1888	106.3			110.2	151.2			102.3	140.7
1889				121.0				114.9	158.8

a Figured from kilograms at United States coining value. b Average for 5 preceding years.

Dr. Soetbeer's figures are in kilograms, and for the table have been reduced to United States coining values, by multiplying by \$664.61393 per kilogram for gold and by \$41.56764 per kilogram for silver. The figures in the same column for 1885 to 1888, inclusive, are from Dr. Soetbeer's memoir on the production of gold and silver from 1885 to 1888, presented to the International monetary congress, at Paris, in 1889.

The figures attributed to Sir Hector Hay are from a table furnished by him to the British commission on "Recent changes in the relative values of the precious metals" (1887). His figures, being given in pounds sterling, have been multiplied by 5 to convert them (approximately) into dollars.

The figures in the column headed "Mint report, 1880", are taken from a table published in the annual report of Hon. Horatio C. Burchard, director of the United States mint, on "Production of gold and silver in the United States" for 1880, page 294. The original authority for this table is not given. The close agreement of these figures between 1853 and 1866 with those given by Sir Hector Hay would indicate that both were taken from the same original source for these years.

The figures in the column headed "Mint report, 1889", are from the annual report of Hon. Edward O. Leech, director of the United States mint, on "Production of gold and silver in the United States" for the year 1889, page 61.

In comparing the figures for silver since 1873 it must be noted that the column headed "Soetbeer" and one of the two columns "Mint report, 1889," give the United States coining value at \$1.2929 per ounce fine, while the other three columns give the commercial value, based on the market price for each year, which value had declined from $1.29 to $0.935 between 1873 and 1889. The figures given in the table have been plotted in the diagram herewith presented, which shows more clearly than the figures themselves both the general trend of variation in the production of gold and silver during the 40 years under consideration and the differences in the estimates of the several authorities.

Considering first the line in the diagram representing the gold production, it is noticed that from 1849 to 1853 the production as given in the table in the report of the director of the mint for 1880 (the original authority of which is not given), as given by Soetbeer (average production from 1850 to 1855), and as given by Sir Hector Hay differ so greatly that there can be no possible means of reconciling them. From 1853 to 1866 Sir Hector Hay's figures practically coincide with those in the mint director's report, showing that they must have been taken from the same original source, while Soetbeer's figures of averages show an approximate agreement with them, but are generally higher. From 1861 to 1874 Sir Hector Hay's figures part company with those of the director of the mint and approach those of Soetbeer, which remain the highest of the three, the director's figures going very much lower, reaching a minimum of 90.8 millions of dollars in 1874, against Sir Hector Hay's figures of 107 millions for that year and Soetbeer's figures of 115.6 millions as the average of the years 1870 to 1875. In 1878 the mint director's figures (report of 1880) reach a still lower minimum of 86.5 millions; but in 1873 a new series of figures begins, taken from the report of the director of the mint of 1889, which, while coinciding with the earlier table for the years 1873, 1874, and 1875, afterward depart so rapidly in the direction of Soetbeer's higher figures as to show 119 millions in 1878, against only 86.5 millions for the same year in the earlier table. This new table of the director of the mint (report of 1889), thus approaching Soetbeer's figures in 1876, thereafter shows a substantial agreement with Soetbeer; Sir Hector Hay's figures at times nearly coincide with them, but at others differ somewhat widely.

The 10 volumes of the report of the director of the mint from 1870 to 1889, inclusive, give tables of the world's production for the 3 or 4 years prior to the date of each volume, distributing the production among different countries. These estimates are made in some cases from official reports obtained by United States consular officers, and in others from technical or financial papers published in those countries; in others by taking Soetbeer's figures. Soetbeer's estimates are likewise made in a similar way; in many cases he accepts the figures of the director of the mint. The figures of Soetbeer and those of the director of the mint are therefore partly independent of and partly dependent upon each other. Since there is a substantial agreement between their figures between 1876 and 1888, and there is no strong reason for preferring one of these authorities to the other, it may safely be assumed that if a curved line be drawn through the diagram representing the figures of each, bisecting their differences as nearly as possible, it will give as near an approximation to the most probable figures as can be obtained. For the years 1857 to 1876 the figures of Sir Hector Hay and Soetbeer appear to agree with each other somewhat more closely than either set agrees with the figures given in the report of the director of the mint for 1880 (authority not given). There seems, therefore, to be a reason for rejecting the latter figures and drawing a curved line which will approximately bisect the differences of Sir Hector Hay and Soetbeer.

Previous to 1857 the figures given by Sir Hector Hay and by the director of the mint differ so widely from those of Soetbeer (except in 1854 and 1857), and previous to 1853 from each other, that Soetbeer's average figures must be accepted, in the absence of any other evidence, as the most probable.

Drawing an irregular curved line on the diagram as thus described, the figures of the most probable value of the world's product of gold from 1850 to 1889, are obtained as follows:

THE WORLD'S GOLD PRODUCTION.

[Probable values in millions of dollars.]

1850 to 1855	a132.5	1867	127.0	1879	114.0
1856	134.0	1868	126.0	1880	108.0
1857	134.0	1869	125.0	1881	104.0
1858	133.0	1870	123.0	1882	100.0
1859	130.0	1871	119.0	1883	97.0
1860	127.0	1872	113.0	1884	100.0
1861	122.0	1873	112.0	1885	106.0
1862	119.0	1874	111.0	1886	106.0
1863	119.0	1875	111.0	1887	106.0
1864	122.0	1876	111.0	1888	110.0
1865	126.0	1877	116.0	1889	120.0
1866	127.0	1878	120.0		

a Average for 5 preceding years.

Referring now to the lines on the diagram representing the silver production, it is noted that from 1850 to 1875 there is a substantial agreement between the figures given by Sir Hector Hay, Soetbeer, and the director of the mint (except that Sir Hector Hay's figures drop far below Soetbeer's in the years 1871 to 1874). It is easy, therefore, to draw a line which shall represent the most probable value between these dates.

After 1874, when the commercial value began to differ widely from the United States coining value, Sir Hector Hay's figures, being commercial values, are omitted from the diagram, and the figures of Soetbeer and the director of the mint only are given. Between these dates there is a wide difference between the figures of Soetbeer and the director of the mint, those of the former being invariably the higher. An attempt has been made to learn the cause of this difference by comparing the figures given by each of these authorities for the principal silver-producing countries, as shown in the table herewith headed "Comparison of estimates of Dr. Soetbeer and the director of the United States mint", and also by referring to Dr. Soetbeer's own explanation of the difference as given in his paper presented at the Paris monetary congress in 1889, already mentioned.

The following quotation is from Dr. Soetbeer's paper (translation):

A fundamental difference exists in the method in accordance with which the shares of the different countries in the total production of the precious metals should be calculated, and material variances in the estimates occur. To illustrate the difference of the method just referred to the following example is given:

THE PRODUCTION OF SILVER IN GERMANY.

YEARS.	GERMAN REPORT. (a)		MINT REPORT, 1887. (b)	
	Product. (Kilograms.)	Value. (Marks.)	Product. (Kilograms.)	Value.
1885	309,418	44,137,793	24,507	$1,021,000
1886	319,598	42,707,549	25,650	1,066,000
1887	367,633	48,158,010	23,929	994,000
1888	406,567	51,425,269		
1889				

a From official statistics of the German empire.
b From report of the director of the mint upon production of the precious metals, 1887.

According to this the American report estimates the silver production of Germany at only about 18 per cent and 6 per cent, respectively, of the amount the imperial statistics positively give for it. The reason for this enormous difference is that the latter give the exact product of the German smelting works (inclusive of the working of imported foreign argentiferous ores, etc.), while the director of the mint of the United States gives as the production of silver in Germany only the presumptive silver contents of German silver ores. In the case of gold, which in Germany is, we may say, obtained almost exclusively from foreign ores, the production of the German smelting works is given in the American report (1887) at 2,251 kilograms fine, as the gold production of Germany.

As a self-evident consequence of the calculation of the production of the precious metals not according to the gross exploitation of the mines, but according to the product of the smelting works, the amounts of gold and silver ores, which in the statistics of many countries were first included in the precious metal production of these countries, must be deducted from our estimate—a deduction which, in many cases, can be made only with the reservation of a very broad margin for possible errors.

Dr. Soetbeer says elsewhere in the same paper:

The presumptive silver contents of the domestic ores exported from the United States is embraced in the figures of the director of the mint, but not the silver obtained from foreign imported ores.

According to our method, which, in the distribution of the production of silver among the different countries, as remarked above, keeps in view the ultimate amount of silver obtained, the reverse of this would have to be done. Now, as in the United States there has been a large quantity of foreign (especially Mexican) silver and other argentiferous ores imported and treated, the above production of silver appears in our table higher than in the report of the director of the mint, which higher figure is, of course, compensated for in the table of the world's production by the fact that like amounts in the silver production of those countries from which the ores were drawn are deducted. It is necessary to proceed here with the greatest caution, making all possible reservation in our approximate estimates, for the reason that there is no accurate information as to the amount of metal that was contained in the ores, even if the amount of exported ores be given approximately correct.

Referring to the uncertain nature of all statistics of production of the precious metals, Dr. Soetbeer says:

The longer and more zealously a conscientious investigator busies himself with the statistics of the production and employment of the precious metals the more will he be convinced that, with some exceptions, the numerical results obtainable relating to such production and employment are of a very uncertain nature; that they possess only the character of a greater or less approach to the reality, and of greater or less probability; that the round numbers laid before the student deserve confidence because apparently most carefully calculated on positive data, and that a continual revision of the estimates seems desirable.

The total amount of the precious metals newly produced during the period of 38 years from 1851 to 1888 must be assumed approximately as follows:

APPROXIMATE PRODUCTION OF PRECIOUS METALS, 1851 TO 1888.

METALS.	Quantity. (Kilograms.)	Value. (Million marks.)
Gold	7,019,338	19,584.7
Silver	71,037,631	11,401.6

Enormous as these sums appear, we believe that in reality the quantities of new silver, and especially of new gold, put upon the market since 1851 are greater rather than smaller than the amounts given above, for in the case of the production of many countries, especially that of Russia and Mexico, for which our tables contain only the declared amounts, it is very probable that the portion which from year to year has escaped declaration and registration is many millions of marks in value, and the several scattered small amounts produced which are not mentioned in the statistics, each of which is, as compared with the world's production, insignificant, constitute, when taken together, considerable sums.

THE WORLD'S SILVER PRODUCTION—COMPARISON OF ESTIMATES OF DR. SOETBEER AND THE DIRECTOR OF THE UNITED STATES MINT.

[Thousands of kilograms.]

YEARS.	TOTAL.		UNITED STATES.		MEXICO.		BOLIVIA, PERU, CHILE.				GERMANY.		OTHER COUNTRIES.	
	Director of mint.	Soetbeer.	Director of mint.	Soetbeer.	Director of mint.	Soetbeer.	Director of mint.			Soetbeer.	Director of mint.	Soetbeer.	Director of mint.	Soetbeer.
							(a)	(b)	(c)					
1877	2,175	2,389	957	957	650	634	....	250	....	350	148	148	170	300
1878	2,293	2,551	1,089	1,089	650	644	....	250	....	350	126	168	178	300
1879	2,314	2,508	982	981	605	699	265	122	....	350	134	178	206	300
1880	2,275	2,480	943	943	605	701	265	122	....	350	134	186	206	300
1881	2,458	2,593	1,035	1,035	666	721	265	122	....	350	187	187	183	300
1882	2,690	2,769	1,126	1,126	704	738	265	128	46	390	215	215	206	300
1883	2,774	2,895	1,112	1,111	711	739	385	160	46	510	143	235	217	300
1884	2,538	2,957	1,174	1,174	656	785	241	160	46	450	28	248	233	300
1885	2,842	3,175	1,242	1,295	773	736	241	210	48	455	25	309	303	380
1886	2,897	3,238	1,227	1,288	794	792	241	210	96	460	26	320	303	378
1887	2,992	3,414	1,284	1,374	904	784	137	200	75	435	32	368	360	453
1888	3,424	3,637	1,424	1,540	995	800	230	186	75	430	32	407	482	460
1889	3,920	....	1,555	....	1,336	....	230	186	75	....	32	....	506	....

a Bolivia. *b* Peru. *c* Chile.

Referring again to the diagram of silver production, it will be noticed that in the year 1884 the figures given by the director of the mint are not only far below Soetbeer's, but they are also far below his own figures for 1883 and 1885, the years immediately preceding and following.

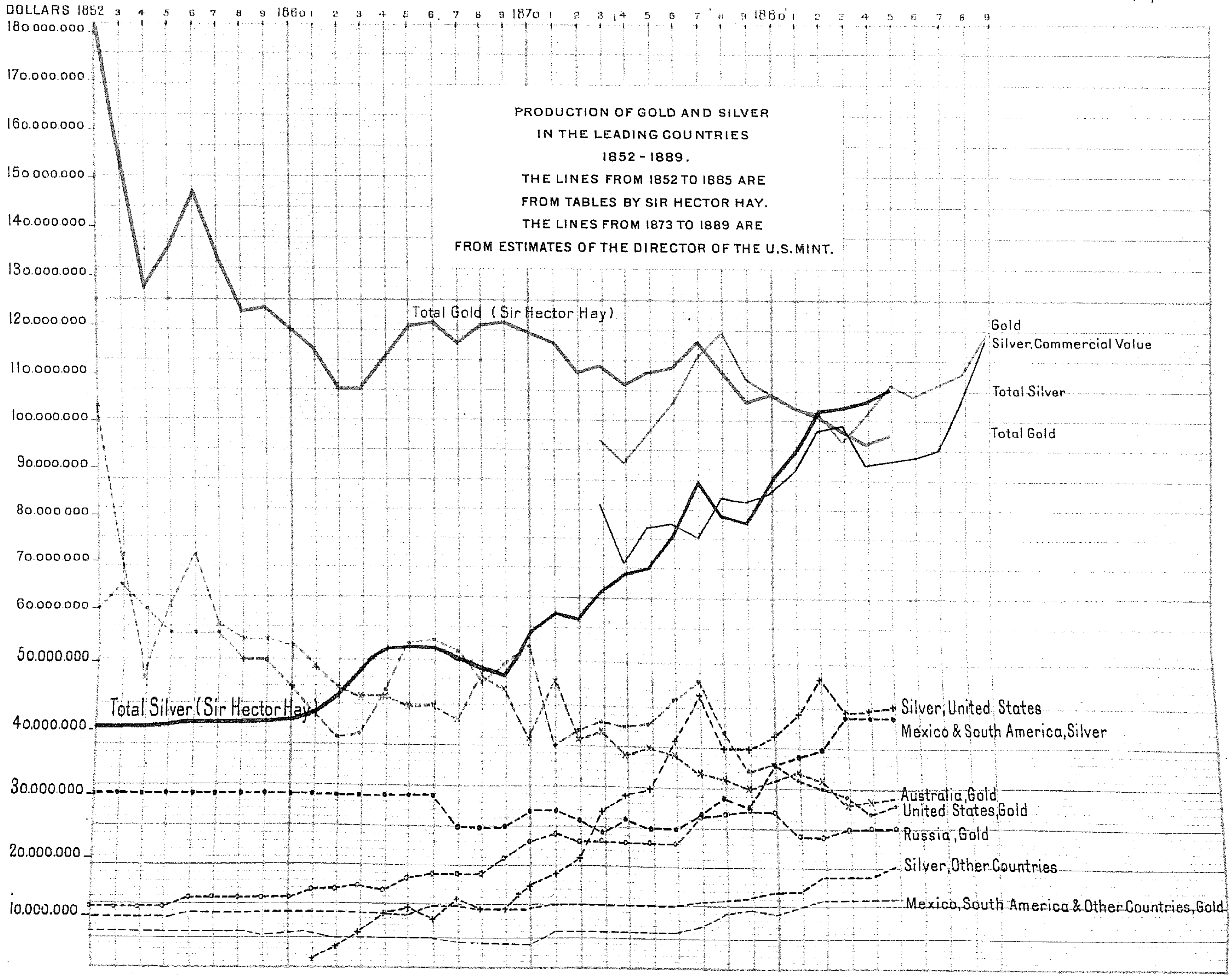
Referring to the table of comparison by countries, it is seen that this apparent decline in production is found in Mexico, where the director reports a decrease of 55,000 kilograms, as against an increase of 46,000 kilograms reported by Soetbeer; in Bolivia, where the director reports a decrease of 141,000 kilograms, against a decrease of 60,000 reported by Soetbeer, and in Germany an apparent decrease of 115,000 kilograms is reported by the director of the mint, against an increase of 13,000 kilograms reported by Soetbeer. The apparent decrease in Germany is due to a change in the method of estimating the German product, as mentioned in the above-quoted extracts of Dr. Soetbeer. Prior to 1884 the figures were made by taking the returns of the smelting works and deducting 88,000 kilograms as the estimated amount of silver contained in imported foreign ores. In 1384 and succeeding years the product is that of the German mines reckoned directly. The director of the mint in his report of 1889 says:

The silver product credited to Germany, however, is the product of its own mines, as shown by its statistical publications. The value of silver contained in exported ores is reported to this bureau by the exporting countries as part of the annual product of their mines, and is credited to the producing countries rather than to the smelting works of Germany.

It would appear, however, from the figures of 1884 that the countries exporting to Germany were either not so credited to the proper extent, or else that there was a remarkable decrease in their production that year.

It may be that in previous years the product was duplicated in the report of the director of the mint, the same bullion being credited both to the country that produced the ore and the country that smelted it. On the other hand, it is possible that in recent years the product has been similarly duplicated by Soetbeer in crediting Germany with the silver produced from imported ores and not deducting this amount from that reported by foreign countries.

Without further evidence than is now at hand as to the preponderance of weight of these two authorities, it is not possible for an impartial student to form a definite conclusion as to which is more likely to give the nearest approximate to correct figures. The diagram would indicate that the decrease of production shown by the mint director's figures for the years 1877 and 1884 is improbable, in view of the fact that there is a general tendency of the production to increase throughout the whole of the last 30 years and that Soetbeer shows no decrease for these years.


PRODUCTION OF GOLD AND SILVER
IN THE LEADING COUNTRIES
1852 - 1889.
THE LINES FROM 1852 TO 1885 ARE
FROM TABLES BY SIR HECTOR HAY.
THE LINES FROM 1873 TO 1889 ARE
FROM ESTIMATES OF THE DIRECTOR OF THE U.S. MINT.
DOLLARS 1852 3 4 5 6 7 8 9 1860 1 2 3 4 5 6 7 8 9 1870 1 2 3 4 5 6 7 8 9 1880 1 2 3 4 5 6 7 8 9
180.000.000
170.000.000
160.000.000
150.000.000
140.000.000
130.000.000
120.000.000
110.000.000
100.000.000
90.000.000
80.000.000
70.000.000
60.000.000
50.000.000
40.000.000
30.000.000
20.000.000
10.000.000
Total Gold (Sir Hector Hay)
Total Silver (Sir Hector Hay)
Gold
Silver, Commercial Value
Total Silver
Total Gold
Silver, United States
Mexico & South America, Silver
Australia, Gold
United States, Gold
Russia, Gold
Silver, Other Countries
Mexico, South America & Other Countries, Gold

In drawing the curve of probable production from 1875 to 1889, the mint director's figures for the years 1877 and 1884 have therefore been rejected, and as even a curve has been drawn as possible between the lines in the diagram representing the figures of the two authorities for the other years. The complete curve then gives the following figures from 1850 to 1889:

WORLD'S PRODUCTION OF SILVER.

[Probable values, in millions of dollars, based on United States coining value of $1.2929 per ounce fine.]

1850 to 1860 (*a*)	40	1865	52	1870	64	1875	82	1880	101	1885	125
1861	45	1866	52	1871	68	1876	88	1881	106	1886	130
1862	46	1867	54	1872	71	1877	93	1882	111	1887	136
1863	49	1868	57	1873	75	1878	97	1883	115	1888	146
1864	52	1869	61	1874	79	1879	99	1884	120	1889	159

a Average for preceding 10 years.

WORLD'S PRODUCTION, BY COUNTRIES, OF GOLD AND SILVER FROM 1880 TO 1889.

The following estimates of the gold and silver production of the world are taken from the reports of the director of the United States mint on the production of gold and silver in the United States. The figures for 1880 are from the report of 1882, those for 1881 from the report of 1884, those for 1882 from the report of 1885, those for 1883 from the report of 1887, those for 1884, 1885, and 1886 from the report of 1888, and those for 1887, 1888, and 1889 from the report of 1890.

WORLD'S PRODUCTION OF GOLD AND SILVER FROM 1880 TO 1889, AS ESTIMATED BY THE DIRECTOR OF THE MINT.

COUNTRIES.	1880.				1881.			
	Gold.		Silver.		Gold.		Silver.	
	Kilograms.	Dollars.	Kilograms.	Dollars.	Kilograms.	Dollars.	Kilograms.	Dollars.
Total	160,152	106,436,786	2,275,082	94,551,060	155,016	103,023,078	2,458,322	102,168,354
United States	54,168	36,000,000	942,987	39,200,000	52,212	34,700,000	1,034,649	43,000,000
Australasia	43,282	28,765,000	5,465	227,125	*a*46,178	30,690,000	*b*3,970	164,983
Mexico	*c*1,488	989,160	*c*605,469	25,167,763	*d*1,292	858,909	*d*665,918	27,675,540
European countries:								
Russia	*c*42,960	28,551,028	*c*11,391	473,519	36,671	24,371,343	7,992	332,198
Germany	*e*350	232,610	*e*134,152	5,576,699	*f*350	232,610	*g*186,990	7,771,304
Austria-Hungary	1,647	1,094,596	48,000	1,994,880	1,867	1,240,808	31,359	1,303,280
Sweden	5	3,323	1,312	54,527	1	665	1,176	48,875
Norway			4,436	184,360			4,812	199,987
Italy	*h*109	72,375	*i*432	17,949	*j*109	72,375	*j*432	17,949
Spain			74,500	3,096,220			*k*74,500	3,096,220
Turkey	7	4,918	1,719	71,441	7	4,918	1,719	71,441
France								
Great Britain								
Dominion of Canada	1,226	815,089	1,641	68,205	1,648	1,094,926	1,641	68,205
South American countries:								
Argentine Republic	*c*118	78,546	*c*10,109	420,225	*l*118	78,546	*l*10,109	420,225
Colombia	*c*6,019	4,000,000	*c*24,057	1,000,000	*l*6,019	4,000,000	*l*24,057	1,000,000
Bolivia	*m*109	72,345	*m*264,677	11,000,000	109	72,375	264,677	11,000,000
Chile	*m*194	128,869	*m*122,275	5,081,747	194	128,869	122,275	5,081,747
Brazil	1,345	893,887			1,116	741,694		
Venezuela	3,423	2,274,692			*k*3,423	2,274,692		
Guiana (British)								
Guianá (Dutch)								
Peru								
Central American states								
Japan	*c*702	466,548	*c*22,460	916,400	*l*702	466,548	*l*22,046	916,400
Africa	*c*3,000	1,993,800			*g*3,000	1,993,800		
China								
India (British)								

a Official for Victoria and New South Wales, with estimated production of the other provinces.
b The mean of the official production for 1880 and 1882.
c Estimated the same as 1879.
d Coinage and export.
e From total production 17 per cent of gold and 25 per cent of silver deducted for foreign ores.
f Estimated same as official statement for 1880.
g Estimated by Dr. A. Soetbeer.
h Estimated.
i Dr. A. Soetbeer.
j Estimated same as official statement for 1877.
k Estimated same as official statement for 1880.
l Estimated same as official statement for 1879.
m Estimated same as 1881.

WORLD'S PRODUCTION OF GOLD AND SILVER, ETC.—Continued.

COUNTRIES.	1882.				1883.			
	Gold.		Silver.		Gold.		Silver.	
	Kilograms.	Dollars.	Kilograms.	Dollars.	Kilograms.	Dollars.	Kilograms.	Dollars.
Total	153,470	101,996,640	2,690,109	111,802,337	143,533	95,392,000	2,774,227	115,297,000
United States	48,902	32,500,000	1,126,083	46,800,000	45,140	30,000,000	1,111,646	46,200,000
Australasia	48,081	31,955,017	2,011	83,592	40,852	27,150,000	3,610	150,000
Mexico	1,409	936,223	703,508	29,237,798	1,438	956,000	711,480	29,569,000
European countries:								
Russia	35,913	23,867,935	7,781	323,427	30,272	20,119,000	9,990	415,000
Germany	376	249,890	214,982	8,934,652	458	304,000	*a*142,700	5,930,000
Austria-Hungary	*b*1,580	1,050,068	*b*47,118	1,958,224	1,638	1,088,000	48,700	2,024,000
Sweden	17	11,298	1,500	62,350	37	25,000	1,583	66,000
Norway	......	......	5,893	244,954	......	......	5,645	235,000
Italy	*c*109	72,375	*c*432	17,949	*d*142	94,000	*d*29,259	1,216,000
Spain	......	......	*e*74,500	3,096,220	......	......	*f*54,335	2,258,000
Turkey	10	6,646	2,164	89,916	*d*10	7,000	*d*1,323	55,000
France	......	......	14,291	594,053	......	......	6,356	264,000
Great Britain	......	......	......	......	2	1,000	8,500	353,000
Dominion of Canada	*g*1,648	1,094,926	*g*1,641	68,205	1,435	954,000	*d*5,030	209,000
South American countries:								
Argentine Republic	*h*118	78,546	*h*10,109	420,225	118	78,000	11,500	478,000
Colombia	5,802	3,856,000	18,283	760,000	*i*5,802	3,856,000	*i*18,287	760,000
Bolivia	*g*109	72,375	*g*264,677	11,000,000	109	72,000	384,985	16,000,000
Chile	245	163,000	128,166	5,325,000	*j*500	332,000	*j*160,000	6,650,000
Brazil	*g*1,116	741,694	......	......	952	633,000	......	......
Venezuela	3,904	2,595,077	......	......	5,023	3,338,000	......	......
Guiana (British)	......	......	......	......	......	......	......	......
Guiana (Dutch)	......	......	......	......	......	......	......	......
Peru	*k*179	119,250	*k*45,909	1,908,000	*j*180	120,000	*j*45,909	1,908,000
Central American states	......	......	......	......	......	......	......	......
Japan	*l*952	632,520	*l*21,121	877,772	*i*290	193,000	*i*12,940	538,000
Africa	*m*3,000	1,993,800	......	......	*n*1,078	717,000	449	19,000
China	......	......	......	......	*o*8,057	5,355,000	......	......
India (British)	......	......	......	......	......	......	......	......

a The production officially reported with a deduction of 88,000 kilograms, given by Dr. Soetbeer for 1884 as the amount from foreign ores smelted.
b Official for Hungary, with former annual production for Austria added.
c Estimated same as official statement for 1877.
d Estimated same as officially communicated for 1886.
e Estimated same as official statement for 1880.
f Estimate of Dr. Soetbeer for 1883.
g Estimated same as official statement for 1881.
h Estimated same as official statement for 1879.
i Estimated same as officially communicated for 1882.
j Estimated same as officially communicated for 1884.
k Estimated same as official statement for 1884.
l Estimated same as official statement for 1883.
m Estimated by Dr. A. Soetbeer, 1879.
n Imported into the United Kingdom from West and South Africa, extracted from board of trade returns by A. Sauerbeck, F. S. S.
o Dr. Ivan C. Michels.

WORLD'S PRODUCTION OF GOLD AND SILVER, ETC.—Continued.

COUNTRIES.	1884.				1885.			
	Gold.		Silver.		Gold.		Silver.	
	Kilograms.	Dollars.	Kilograms.	Dollars.	Kilograms.	Dollars.	Kilograms.	Dollars.
Total	153, 070	101, 729, 600	2, 537, 564	105, 461. 350	156. 156	103, 779, 600	2. 841, 573	118, 095, 150
United States	46, 344	30, 800, 000	1, 174, 206	48. 800, 000	47, 848	31, 800, 000	1, 241, 578	51, 600, 000
Australasia	42, 558	28, 284, 000	4. 525	188, 000	41, 287	a27, 439, 000	25, 220	1, 048, 000
Mexico	1, 780	1, 183, 000	655, 870	27, 258, 000	1, 304	867, 000	772, 670	32, 112, 000
European countries:								
Russia	32, 913	21, 874, 000	9, 360	389, 000	38, 125	25, 338, 000	15, 550	646, 000
Germany	555	369, 000	27, 598	1, 147, 000	1, 378	916, 000	24, 567	1. 021, 000
Austria-Hungary	1, 658	1, 102, 000	49, 300	2, 049, 000	1. 774	1. 179, 000	52, 748	2, 192, 200
Sweden	20	13, 000	1. 816	75, 500	47	31, 000	2, 326	96, 000
Norway	....	....	6, 387	265, 500	....	....	7. 200	299, 000
Italy	b195	129, 600	b33, 839	1, 406, 350	b195	129, 600	b33, 839	1. 406, 350
Spain	....	....	c54, 335	2, 258, 000	....	....	c54, 335	2, 258, 000
Turkey	b10	7, 000	b1, 323	55, 000	b10	7, 000	b1, 323	55, 000
France	....	....	5, 905	245, 000	....	....	51, 000	2, 120, 000
Great Britain	....	....	8, 060	335, 000	....	....	7, 607	316, 000
Dominion of Canada	d1, 435	954, 000	b5, 030	209, 000	1, 679	1, 116, 000	b5, 030	209, 000
South American countries:								
Argentine Republic	d118	78, 000	d11, 500	478, 000	d118	78, 000	d11, 500	478, 000
Colombia	e5, 802	3, 856, 000	e18, 287	760, 000	b3, 762	2, 500, 000	b9, 625	400, 000
Bolivia	d109	72, 000	f240, 616	10, 000, 000	d109	72, 000	f240. 616	10, 000, 000
Chile	500	332, 000	160. 000	6, 650, 000	b500	332, 000	b210, 000	8, 727, 600
Brazil	d952	633, 000	....	....	1, 204	800, 000	2, 640	110, 000
Venezuela	g7, 033	4, 674. 000	....	....	7, 033	4, 674, 000	....	....
Guiana (British)	....	....	....	....	....	....	....	....
Guiana (Dutch)	....	....	....	....	....	....	....	....
Peru	180	120, 000	45, 909	1, 908, 000	226	150. 000	47, 840	1, 988, 000
Central American states	....	....	....	....	9	6, 000	....	....
Japan	296	197, 000	23, 460	975, 000	265	176, 000	23, 085	960, 000
Africa	g1, 250	830. 000	h238	10, 000	h2, 083	1, 384, 000	h1, 274	53, 000
China	h9, 362	6, 222, 000	....	....	i6, 997	4, 650. 000	....	....
India (British)	....	....	....	....	203	135, 000	....	....

a G. W. Griffin, United States consul at Sydney, reports the gold production of Australasia for 1886 at $25,883,884, and for 1885 at $27,361,603.

b Estimated same as officially communicated for 1886.

c Estimate of Dr. Soetbeer for 1883.

d Estimate of the bureau of the mint, based upon the production for 1883.

e Estimated same as officially communicated for 1882.

f Estimate of the bureau of the mint, based upon the annual average credited Bolivia by Dr. A. Soetbeer, and confirmed by official statistics of exports and coinage for 1887.

g Estimate of the bureau of the mint, based upon the production for 1885.

h Imports into the United Kingdom from West and South Africa, extracted from board of trade returns by A. Sauerbeck, F. S. S.

Dr. Ivan C. Michels.

WORLD'S PRODUCTION OF GOLD AND SILVER—Continued.

COUNTRIES.	1886.				1887.			
	Gold.		Silver.		Gold.		Silver.	
	Kilograms.	Dollars.	Kilograms.	Dollars.	Kilograms.	Dollars.	Kilograms.	Dollars.
Total	149,338	99,250,877	2,896,882	120,394,400	159,155	105,774,955	2,990,398	124,280,973
United States	52,663	35,000,000	1,227,141	51,000,000	49,654	33,000,000	1,283,855	53,357,000
Australasia	39,761	a26,425,000	29,403	1,222,000	41,119	27,327,600	6,422	266,900
Mexico	924	614,000	794,033	33,000,000	1,240	824,000	904,000	37,570,000
European countries:								
Russia	30,872	20,518,000	12,707	528,100	30,232	20,092,000	13,522	562,000
Germany	1,065	708,000	25,650	1,066,000	2,251	1,496,000	31,564	1,311,798
Austria-Hungary	b1,774	1,179,000	b52,748	2,192,200	1,877	1,247,450	53,391	2,218,900
Sweden	67	45,000	3,081	128,000	84	55,550	c5,828	242,250
Norway	....	....	b7,200	299,000	....	....	d5,147	214,000
Italy	195	129,600	33,839	1,406,350	c195	129,600	c33,839	1,406,350
Spain	....	....	e54,335	2,258,000	....	....	58,711	2,440,000
Turkey	10	7,000	1,323	55,000	c10	7,000	c1,323	55,000
France	....	....	46,789	1,944,550	....	....	54,314	2,257,300
Great Britain	....	....	10,124	420,750	2	1,000	9,964	414,100
Dominion of Canada	2,002	1,330,442	5,030	209,000	1,773	1,178,637	10,868	451,680
South American countries:								
Argentine Republic	30	20,000	1,444	60,000	45	30,000	722	30,000
Colombia	3,762	2,500,000	9,625	400,000	4,514	3,000,000	24,061	1,000,000
Bolivia	f109	72,000	g240,616	10,000,000	143	95,000	137,468	5,713,170
Chile	500	332,000	210,000	8,727,600	2,379	1,581,400	199,516	8,291,920
Brazil	h1,502	998,000	h141	5,850	984	654,000	....	....
Venezuela	i5,020	3,336,000	....	....	2,960	1,967,216	....	....
Guiana (British)	....	....	....	....	370	245,902	....	....
Guiana (Dutch)	....	....	....	....	712	j473,000	....	....
Peru	k170	113,000	k96,246	4,000,000	d158	105,000	l75,263	3,128,000
Central American states	m131	87,000	....	....	226	n150,000	48,123	n2,000,000
Japan	492	327,235	32,242	1,340,000	564	375,000	32,065	1,332,650
Africa	o2,163	1,438,000	3,165	132,000	2,888	1,919,600	432	17,960
China	p5,492	3,650,000	....	....	p14,294	9,500,000	....	....
India (British)	634	421,600	....	....	481	320,000	....	....

a G. W. Griffin, United States consul at Sydney, reports the gold production of Australasia for 1886 at $25,883,884, and for 1885 at $27,361,603.

b Estimate of the bureau of the mint, based upon the production for 1885.

c Estimated the same as officially communicated for 1886.

d Estimated the same as officially communicated for 1889.

e Estimate of Dr. Soetbeer for 1883.

f Estimate of the bureau of the mint, based upon the production for 1883.

g Estimate of the bureau of the mint, based upon the annual average credited Bolivia by Dr. A. Soetbeer and confirmed by official statistics of exports and coinage for 1887.

h Exports of gold and silver through the customhouse at Rio de Janeiro.

i Production of 2 mills of the El Callao Company.

j "Jaarcijifers over 1888 en Vorige Jaaren", No. 8, page 115.

k Estimate of the bureau of the mint, based upon the exports of bullion and ore officially reported for 1886.

l Estimated the same as officially communicated for 1888.

m Estimated same as officially communicated for 1887.

n Rough estimates, based on exports.

o Imports into United Kingdom from West and South Africa, extracted from board of trade returns by A. Sauerbeck, F. S. S.

p Imports of gold into Great Britain from China.

WORLD'S PRODUCTION OF GOLD AND SILVER—Continued.

COUNTRIES.	1888.				1889.			
	Gold.		Silver.		Gold.		Silver.	
	Kilograms.	Dollars.	Kilograms.	Dollars.	Kilograms.	Dollars.	Kilograms.	Dollars.
Total	165,809	110,190,915	3,385,606	140,706,413	182,021	120,971,514	3,820,002	158,759,468
United States	49,917	33,175,000	1,424,326	59,195,000	49,353	32,800,000	1,555,486	64,646,000
Australasia	42,974	28,560,660	120,308	a5,000,000	49,784	33,086,700	144,369	a6,000,000
Mexico	1,465	974,000	995,500	41,373,000	1,053	700,000	1,335,828	55,517,000
European countries:								
Russia	32,052	21,302,000	14,523	604,000	34,867	23,173,000	14,389	598,000
Germany	1,792	1,190,963	32,051	1,332,022	1,958	1,301,286	32,040	1,331,576
Austria-Hungary	1,820	1,209,572	52,128	2,166,440	2,198	1,461,000	52,651	2,188,000
Sweden	76	50,000	4,648	193,000	74	48,900	4,267	177,400
Norway	....	....	5,147	214,000	....	....	5,147	214,000
Italy	148	98,000	35	1,454	b148	98,000	b35	1,454
Spain	....	....	51,502	2,140,400	....	....	b51,502	2,140,400
Turkey	c10	7,000	c1,323	55,000	10	7,000	c1,323	55,000
France	....	....	49,396	2,053,000	....	....	b49,396	2,053,000
Great Britain	220	146,000	9,047	376,000	97	64,370	9,522	395,734
Dominion of Canada	1,673	1,111,959	9,264	385,000	1,919	1,275,045	b9,264	385,000
South American countries:								
Argentine Republic	47	31,000	10,226	425,000	b47	31,000	b10,226	425,000
Colombia	4,514	3,000,000	24,061	1,000,000	3,762	2,500,000	31,280	1,300,000
Bolivia	90	59,800	230,460	9,578,000	b90	59,800	b230,460	9,578,000
Chile	2,953	1,962,430	185,851	7,723,957	2,162	1,436,600	123,695	5,140,764
Brazil	670	445,300	....	....	670	b445,300	....	....
Venezuela	2,130	1,415,598	....	....	2,765	1,838,000	....	....
Guiana (British)	450	299,070	....	....	882	586,177	....	....
Guiana (Dutch)	487	d324,000	....	....	487	324,000	....	....
Peru	158	105,000	75,263	3,128,000	140	93,044	68,575	2,850,000
Central American states	226	e150,000	48,123	e2,000,000	226	e150,000	48,123	e2,000,000
Japan	f606	403,000	f42,424	1,763,140	f606	403,000	f42,424	1,763,140
Africa	6,771	4,500,000	....	....	12,920	8,586,632	....	....
China	g13,542	9,000,000	....	....	13,542	b9,000,000	....	....
India (British)	1,018	676,563	....	....	2,261	1,502,660	....	....

a Estimate of the bureau of the mint.
b Estimated the same as officially communicated for 1888.
c Estimated the same as officially communicated for 1886.
d "Jaarcijifers over 1888 en Vorige Jaaren", No. 8, page 115.
e Rough estimates, based on exports.
f Product of private mines in 1888; government mines in 1889.
g Imports of gold into Great Britain and British India from China.

ESTIMATED GOLD AND SILVER PRODUCTION OF THE WORLD, 1852 TO 1885.(a)

[Values in millions of dollars.]

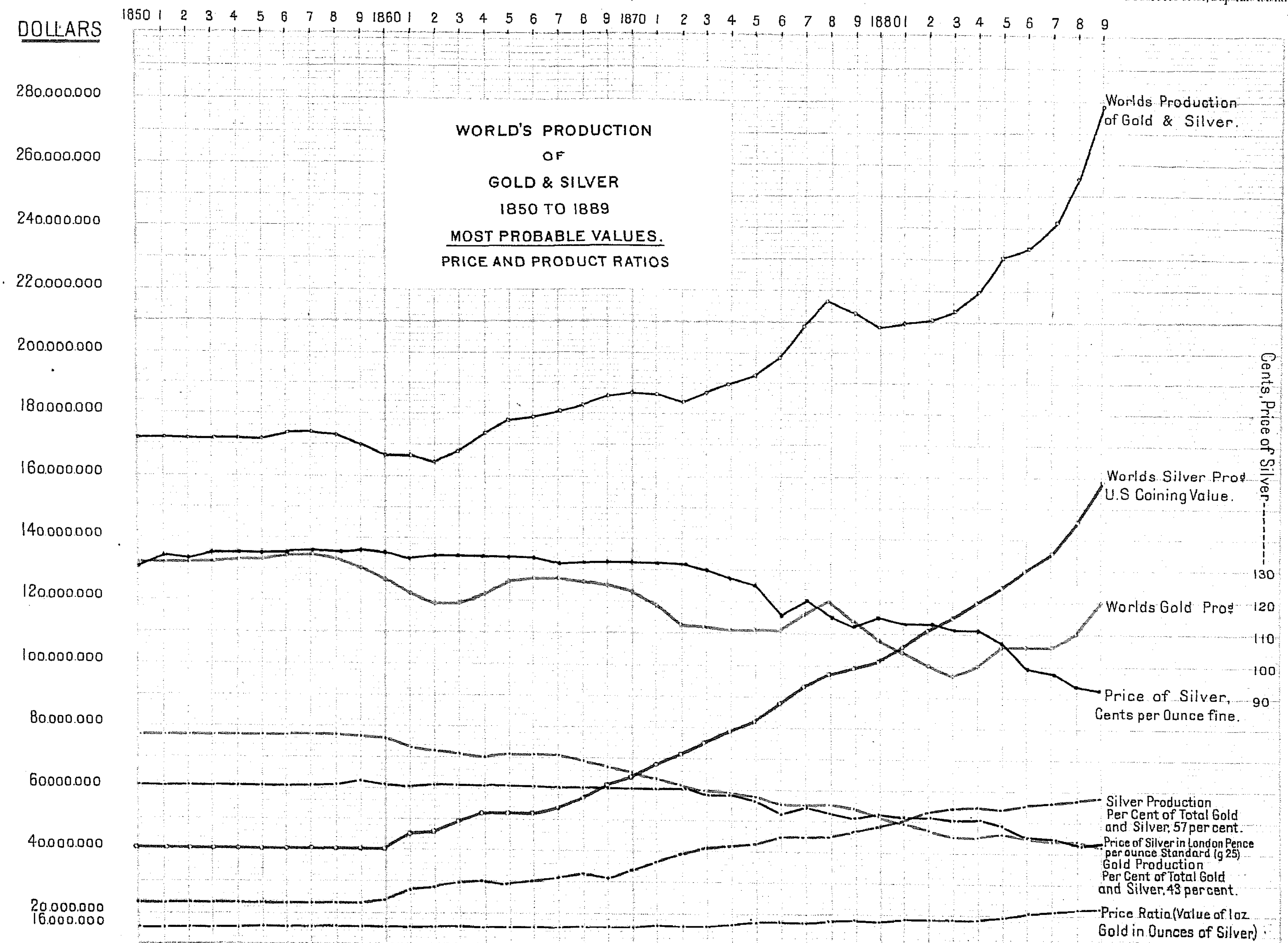
GOLD PRODUCTION.							SILVER PRODUCTION.					
Years.	Total.	Aus-tralasia.	United States.	Mexico and South America.	Russia.	Other coun-tries.	Years	Total.	United States.	Mexico and South America.	Germany.	Other coun-tries.
1852	182.5	103.0	60.0	5.0	12.0	2.5	1852	40.5	....	30.0	2.0	8.5
1853	155.0	70.5	65.0	5.0	12.0	2.5	1853	40.5	....	30.0	2.0	8.5
1854	127.0	47.5	60.0	5.0	12.0	2.5	1854	40.5	....	30.0	2.0	8.5
1855	135.0	60.5	55.0	5.0	12.0	2.5	1855	40.5	....	30.0	2.0	8.5
1856	147.5	71.5	55.0	5.0	13.5	2.5	1856	41.0	....	30.0	2.5	8.5
1857	133.0	57.0	55.0	5.0	13.5	2.5	1857	41.0	....	30.0	2.5	8.5
1858	124.0	53.5	50.0	4.5	13.5	2.5	1858	41.0	....	30.0	2.5	8.5
1859	124.5	54.0	50.0	4.5	13.5	2.5	1859	40.5	....	30.0	2.5	8.0
1860	119.0	52.5	46.0	4.5	13.5	2.5	1860	41.0	....	30.0	3.0	8.0
1861	114.0	49.0	43.0	4.5	15.0	2.5	1861	43.0	2.0	30.0	3.0	8.0
1862	107.0	46.5	39.0	4.0	15.0	2.5	1862	45.5	4.5	30.0	3.0	8.0
1863	106.5	44.5	40.0	4.0	15.5	2.5	1863	49.5	8.5	30.0	3.0	8.0
1864	113.0	45.5	46.0	4.0	15.0	2.5	1864	52.0	11.0	30.0	3.0	8.0
1865	120.0	44.0	53.0	4.0	16.5	2.5	1865	52.5	11.5	30.0	3.0	8.0
1866	118.5	41.5	53.5	4.0	17.0	2.5	1866	52.0	10.0	30.0	4.0	8.0
1867	116.0	41.5	51.5	3.5	17.0	2.5	1867	50.5	13.5	25.0	4.0	8.0
1868	119.0	47.5	48.0	3.0	18.0	2.5	1868	49.0	12.0	25.0	4.0	8.0
1869	121.0	46.5	49.5	2.5	20.0	2.5	1869	49.0	12.0	25.0	4.0	8.0
1870	119.0	38.5	53.0	2.5	22.5	2.5	1870	55.5	16.0	27.5	4.0	8.0
1871	116.5	48.0	37.0	5.0	24.0	2.5	1871	59.0	19.0	27.5	6.5	6.0
1872	110.0	39.0	40.5	5.0	23.0	2.5	1872	58.5	20.0	26.0	6.5	6.0
1873	111.5	40.0	41.5	5.0	22.5	2.5	1873	64.0	27.5	24.0	6.5	6.0
1874	107.5	36.5	41.0	5.0	22.5	2.5	1874	68.0	29.5	26.0	6.5	6.0
1875	110.5	37.5	42.5	5.0	22.5	3.0	1875	68.5	31.0	25.0	6.5	6.0
1876	111.5	36.0	45.0	5.0	22.5	3.0	1876	77.0	39.0	25.0	5.5	7.5
1877	117.0	33.5	47.5	6.0	27.0	3.0	1877	87.0	46.0	27.5	6.0	7.5
1878	110.5	32.5	40.0	7.5	27.0	3.5	1878	80.5	37.5	29.5	6.0	7.5
1879	104.0	31.0	34.0	7.5	27.5	4.0	1879	79.0	37.5	27.5	6.5	7.5
1880	106.0	32.5	35.0	7.5	27.0	4.0	1880	89.0	39.5	34.5	7.0	8.0
1881	103.0	33.5	33.0	8.0	24.0	4.5	1881	94.0	43.0	36.0	7.0	8.0
1882	101.0	32.	31.5	8.5	23.5	5.0	1882	102.5	48.0	37.5	8.0	9.0
1883	98.0	29.0	30.5	8.5	25.0	5.0	1883	103.0	43.0	42.5	8.5	9.0
1884	95.5	29.5	27.5	8.5	25.0	5.0	1884	104.0	43.5	42.5	9.0	9.0
1885	97.5	30.0	29.0	8.5	25.0	5.0	1885	106.5	44.5	42.5	9.5	10.0

a From tables by Sir Hector Hay, "Report of British commission on relative changes of the precious metals", 1887.

WORLD'S PRODUCTION OF GOLD AND SILVER, PRICE OF SILVER, AND RATIO OF GOLD TO SILVER.

A study of the table on the following page and the diagram of the world's annual production of gold and silver, and the price of silver from 1850 to 1889, shows that the world's gold production from 1850 to 1857 remained nearly constant at about $134,000,000; then decreased irregularly till 1883, reaching a minimum of $97,000,000; then increased irregularly to 1889, when the product was $120,000,000. The silver production remained nearly constant from 1850 to 1860 at about $40,000,000, increasing slowly to 1866 to $52,000,000; then increased steadily and rapidly to 1887, and still more rapidly in 1888 and 1889 to $159,000,000.

The ratio of total value of silver product (at United States coining value) to that of the total of both gold and silver remained nearly constant, about 24 per cent, until 1860, increasing irregularly to 30 per cent in 1867, then steadily to 57 per cent in 1889, becoming equal to gold, or 50 per cent, in 1881. The production of silver and the ratio of silver production to total of silver and gold thus both had a period of slow increase from 1860 to 1867, and then a rapid increase, beginning in 1867 and lasting to the present time. The price of silver remained nearly constant (at over 60 pence per ounce standard in London, equal to over $1.32 per ounce fine) until 1872, being unaffected either by the decrease in the gold production or by the increase in silver production. In 1872 the rapid decrease in gold production, which had taken place for 4 years previously, was arrested, and for the next 4 years the decrease was very slight, and in the 10 years following a considerable increase took place. At this time (1872) no change took place in the rate of increase of silver production, this rate being nearly the same from 1867 to 1877; yet in 1873 began the decrease in price of silver, which has continued with but slight fluctuations to the present time. During the 23 years (1850 to 1872) the whole extent of the variation in price was only between $1.36 and $1.32 per ounce, or 3.8 cents, while in the 17 years, 1872 to 1889, inclusive, it declined from $1.322 to $0.936, or 38.6 cents, or over 29 per cent.


DOLLARS
280.000.000
260.000.000
240.000.000
220.000.000
200.000.000
180.000.000
160.000.000
140.000.000
120.000.000
100.000.000
80.000.000
60000.000
40.000.000
20.000.000
16.000.000
1850 1 2 3 4 5 6 7 8 9 1860 1 2 3 4 5 6 7 8 9 1870 1 2 3 4 5 6 7 8 9 1880 1 2 3 4 5 6 7 8 9
WORLD'S PRODUCTION
OF
GOLD & SILVER
1850 TO 1889
MOST PROBABLE VALUES.
PRICE AND PRODUCT RATIOS
Worlds Production of Gold & Silver.
Worlds Silver Prod U.S Coining Value.
Cents, Price of Silver
130
120
110
100
90
Worlds Gold Prod
Price of Silver, Cents per Ounce fine.
Silver Production Per Cent of Total Gold and Silver, 57 per cent.
Price of Silver in London Pence per ounce Standard (g 25)
Gold Production Per Cent of Total Gold and Silver, 43 percent.
Price Ratio (Value of 1oz. Gold in Ounces of Silver)

MOST PROBABLE VALUES OF THE WORLD'S PRODUCTION OF GOLD AND SILVER, PRICE OF SILVER, AND RATIO OF GOLD TO SILVER.

YEARS.	PRODUCTION. (a) (Value in millions of dollars.)			PERCENTAGE OF TOTAL.		Price of silver in London. (Pence per ounce standard.)	Value of silver per fine ounce.	Price ratio 1 ounce gold. (Ounces silver.)
	Total gold and silver.	United States coining value. Gold.	United States coining value. Silver.	Gold.	Silver.			
1850 to 1855	172	132	40	76.7	23.3	61.250	$1.337	15.42
1856	174	134	40	77.0	23.0	61.313	1.344	15.34
1857	174	134	40	77.0	23.0	61.750	1.353	15.27
1858	173	133	40	76.9	23.1	61.313	1.344	15.36
1859	170	130	40	76.5	23.5	62.063	1.360	15.21
1860	167	127	40	76.0	24.0	61.688	1.352	15.30
1861	167	122	45	73.1	26.9	60.813	1.333	15.48
1862	165	119	46	72.1	27.9	61.438	1.346	15.36
1863	168	119	49	70.8	29.2	61.375	1.345	15.38
1864	174	122	52	70.1	29.9	61.375	1.345	15.39
1865	178	126	52	70.8	29.2	61.063	1.338	15.43
1866	179	127	52	70.9	29.1	61.125	1.339	15.44
1867	181	127	54	70.2	29.8	60.563	1.328	15.57
1868	183	126	57	68.9	31.1	60.500	1.326	15.61
1869	186	125	61	67.2	32.8	60.438	1.325	15.60
1870	187	123	64	65.8	34.2	60.563	1.328	15.60
1871	187	119	68	63.6	36.4	60.500	1.326	15.58
1872	184	113	71	61.4	38.6	60.313	1.322	15.64
1873	187	112	75	59.9	40.1	59.250	1.298	15.93
1874	190	111	79	58.4	41.6	58.313	1.278	16.16
1875	193	111	82	57.5	42.5	56.875	1.246	16.63
1876	199	111	88	55.8	44.2	52.750	1.156	17.80
1877	209	116	93	55.5	44.5	54.813	1.201	17.19
1878	217	120	97	55.3	44.7	52.563	1.152	17.96
1879	213	114	99	53.5	46.5	51.250	1.123	18.39
1880	209	108	101	51.7	48.3	52.250	1.145	18.06
1881	210	104	106	49.5	50.5	51.938	1.138	18.24
1882	211	100	111	47.4	52.6	51.813	1.136	18.27
1883	212	97	115	45.8	54.2	50.625	1.110	18.65
1884	220	100	120	45.5	54.5	50.750	1.113	18.63
1885	231	106	125	45.9	54.1	48.563	1.065	19.39
1886	236	106	130	44.9	55.1	45.375	0.995	20.78
1887	242	106	136	43.8	56.2	44.625	0.978	21.13
1888	256	110	146	43.0	57.0	42.875	0.940	21.99
1889	279	120	159	43.0	57.0	42.688	0.936	22.09

a The figures of production are the "most probable values" arrived at from a comparison of the tables of Soetbeer, the director of the mint, and Sir Hector Hay. The price of silver is taken from the report of the director of the mint for 1889. The price ratio is from Soetbeer's tables down to 1885, and from 1886 to 1889 is calculated from the London price.

The diagram does not reveal the cause of the decline in the price of silver, for if it be assumed that the ratio of the production of silver to that of gold controls the price of the former, then the decrease in the price should have begun in 1860, when the ratio of silver product began to increase, and the decrease would have been more pronounced in 1867, when the silver product increased more rapidly and the gold production decreased.

There is nothing in the figures or in the diagram to explain why the decline began in 1873 instead of in 1860 or 1867.

A study of Soetbeer's figures for 380 years, from 1493 to 1873, will also show no relation between the relative production of gold and silver, and from 1800 to 1870, although the value of the product of the two metals varied from 3.227 silver to 1 of gold down to 0.44 silver to 1 of gold, the relative price varied only between 15.41 and 15.83 to 1. From the year 1873 to the present time, however, there appears to be a very close agreement between the product ratio and the price ratio, as shown by the coincidence between the curves on the diagram representing "gold production, per cent of total gold and silver", and price of silver in pence in London. Thus, in 1873 the total value of the gold product, expressed as a percentage of the total of the gold and silver, was 59.9, and in 1889 it was 43; the price of silver in London in 1873 was 59.25 pence, and in 1889 42.69 pence.

Of the possible causes of the phenomenon of the steadiness in price of silver until 1873 and the steady decline since that time many explanations are given in the report of the British commission on the recent changes in the relative values of the precious metals. The cause which seems to have most weight in the opinion of all the members of the committee is the cessation in 1873 of the free coinage of silver in Germany, Holland, and the Latin

Union, comprising France, Belgium, Italy, Switzerland, and Greece. In the conclusion of their report, approved by all the members of the commission, they say:

We are of the opinion that the true explanation of the phenomena which we are directed to investigate is to be found in a combination of causes, and can not be attributed to any one cause alone. The action of the Latin Union in 1873 broke the link between gold and silver, which had kept the price of the former, as measured by the latter, constant at above the legal ratio, and when this link was broken the silver market was open to the influence of all the factors which go to affect the price of a commodity. These factors happen since 1873 to have operated in the direction of a fall in the gold price of that metal.

Mr. George F. Becker, United States geologist, in a paper on the "Relative production and relative value of the precious metals", printed in Mr. Edward Atkinson's report on bimetallism, gives a table and diagram showing that the relative product and the relative value of gold and silver bore no relation to each other between 1493 and 1873, but that since 1873 the two ratios have been closely connected. He explains the difference between the periods before and after 1873 as follows:

The statement that the value of silver relatively to gold remained substantially constant for over 200 years at about 1 to 15.5 is equivalent to the statement that in such quantities as silver bullion was offered to buyers it found a market at that price, and that silver coin was always exchangeable for gold at the same figures.

This stability in the price of silver could be maintained only so long as the quantity of circulating medium demanded by trade, added to the inevitable losses and waste of the metals and to the quantity urgently demanded at the standard price or above it for industrial consumption and for permanent exportation to semicivilized countries, equaled or exceeded the available supply. It is clear that this state of things is compatible only with a moderate production, for the moment that more of either metal was put on the market than could be absorbed in these ways it would be more profitable to the producers to submit to a discount than to hold their bullion.

Great fluctuations in the ratio of the gold product to the silver product can thus occur without necessarily affecting the price of silver to a considerable extent so long as the total product of the precious metals does not exceed the demand of the commercial world for coin plus the demand for these metals at coining rates for nonmonetary application.

It is certain that prior to 1873 the coinage laws fixed the price of silver and that the national treasuries were able to control the market for silver, for in no other way could considerable fluctuations have been avoided. It is also certain that in 1873 the laws ceased to determine the price, as if there were an excess of silver in the market, and that since that time the price of silver has been chiefly determined by the ratio of the production of silver to that of gold, as it would be if either of the two metals were produced in excess. The analysis of Dr. Soetbeer and the coinage statistics also show that a diminishing proportion of the yield of each metal is added to the available stock of coin. All of these facts point to the conclusion that the supply of silver is now greater than the demand for it at coining rates.

THE RELATION OF THE PRICE OF SILVER TO THE PRICE OF COMMODITIES.

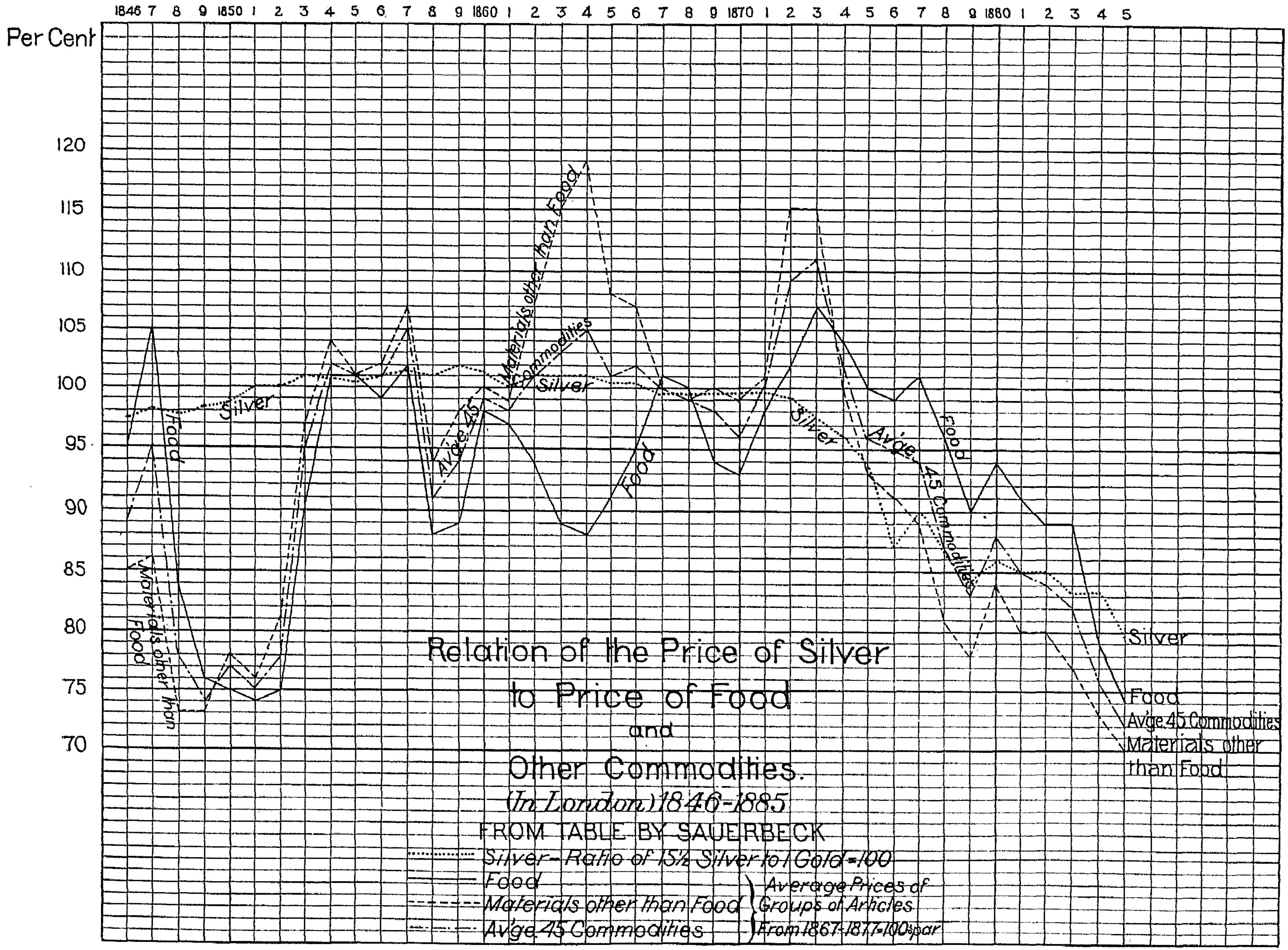
In the discussion of the relative product and the relative price of gold and silver, it has been shown that prior to 1873 the price of silver was not controlled by the ratio of the product of the two metals, but that since 1873 the price of silver appears to be, if not controlled, at least strongly influenced by the ratio which the product of silver bears to the total product of both gold and silver.

Prior to 1873 the price of silver in gold, or the ratio of gold to silver, remained nearly constant for 200 years, the two metals being maintained at a level by the coinage laws of the leading civilized nations; but since 1873, when free coinage of silver ceased, silver became a commodity, and its price thereafter fluctuated in the same manner as other commodities. The relation of the price of silver to the price of other commodities is clearly shown in a table presented by Mr. Augustus Sauerbeck to the British commission on "Recent changes in the relative value of the precious metals" (first report, page 317), giving the "index numbers" from 1846 to 1885 of the prices (in London) of 45 commodities, including vegetable food, animal food, sugar, coffee and tea, minerals, textiles, and sundry materials, and of the prices of silver. The table following is summarized from the table of Mr. Sauerbeck, giving his principal divisions of food, total materials other than food, total of 45 commodities, and silver. The figures for silver are the percentage values as compared with silver at 60.84 pence per ounce, being the parity between gold and silver at 1 to 15.5. The index numbers for the other commodities are percentages compared with the average prices for the years 1867 to 1877.

The accompanying diagram, plotted from the table, shows that the price of silver remained practically constant between 1846 and 1873, fluctuating only between 97.4 and 102 per cent of the par ratio of 15.5 to 1, while the price of commodities fluctuated violently, the index number for the total of 45 commodities falling from 95 in 1847 to 74 in 1849, rising from 75 in 1851 to 102 in 1854 and to 105 in 1857, dropping to 94 in 1859 and rising to 105 in 1864, dropping slowly to 96 in 1870 and rising to 111 in 1873. The index numbers of food and of materials other than food follow quite closely the figures representing the total of 45 commodities, except during the years 1861 to 1867, including the period of the American war. During this period the index numbers of food were as low as 88 (in 1864), while at the same date the index number of materials other than food rose to 119. After 1867 the index numbers of food and of materials again showed a correspondence.

Since 1873 there has been a steady downward tendency of the prices of both food and material, the price index numbers of food, however, being higher than those of materials, the index numbers of the 45 commodities falling nearly midway between those of food and of materials.

The relative price of silver as compared with the par ratio of 15.5 to 1 follows the index numbers of the 45 commodities quite closely, showing that since 1873 silver has become a commodity and is subject to the same laws of fluctuation of price as other commodities.


Relation of the Price of Silver to Price of Food and Other Commodities.
(In London) 1846-1885
FROM TABLE BY SAUERBECK
Silver—Ratio of 15½ Silver to 1 Gold = 100
Food
Materials other than Food
Avge. 45 Commodities
Average Prices of Groups of Articles From 1867-1877 = 100 par
Per Cent
120
115
110
105
100
95
90
85
80
75
70
1846 7 8 9 1850 1 2 3 4 5 6 7 8 9 1860 1 2 3 4 5 6 7 8 9 1870 1 2 3 4 5 6 7 8 9 1880 1 2 3 4 5
Silver
Food
Avge. 45 Commodities
Materials other than Food

MR. A. SAUERBECK'S INDEX NUMBERS COMPARED WITH RATIO OF SILVER AND GOLD.

[Average price of groups of articles from 1867 to 1877.]

YEARS.	INDEX NUMBERS.				YEARS.	INDEX NUMBERS.			
	Food.	Materials.	Total 45 commodities.	Silver. (a)		Food.	Materials.	Total 45 commodities.	Silver. (a)
1846	95	85	89	97.5	1866	95	107	102	100.5
1847	105	86	95	98.1	1867	101	100	100	99.7
1848	84	73	78	97.8	1868	100	99	99	99.6
1849	76	73	74	98.2	1869	94	100	98	99.6
1850	75	78	77	98.7	1870	93	99	96	99.6
1851	74	76	75	99.9	1871	98	101	100	99.7
1852	75	81	78	99.9	1872	102	115	109	99.2
1853	91	97	95	101.2	1873	107	114	111	97.4
1854	101	104	102	101.1	1874	104	100	102	95.8
1855	101	101	101	100.7	1875	100	93	96	93.3
1856	99	102	101	101.0	1876	99	91	95	86.7
1857	102	107	105	101.5	1877	101	89	94	90.2
1858	88	94	91	101.0	1878	96	81	87	86.4
1859	89	98	94	102.0	1879	90	78	83	84.2
1860	98	100	99	101.4	1880	94	84	88	85.9
1861	97	99	98	99.9	1881	91	80	85	85.0
1862	94	107	101	100.9	1882	89	80	84	84.9
1863	89	115	103	101.1	1883	89	77	82	83.1
1864	88	119	105	100.9	1884	79	73	76	83.3
1865	91	108	101	100.3	1885	74	70	72	79.9

a The figures under "Silver" represent the price of silver as compared with 60.84 pence per ounce, being the parity between gold and silver at the ratio of 1 to 15.5.

To complete the statistics of the market values of the precious metals, the following tables, taken from the report of the director of the United States mint, are given to show the commercial ratio of silver to gold each year since 1687, and the highest, lowest, and average price of bar silver in London per ounce, British standard (0.925), since 1833, and the equivalent in United States gold coin of an ounce 1,000 fine, taken at the average price:

COMMERCIAL RATIO OF SILVER TO GOLD EACH YEAR SINCE 1687.

[From 1687 to 1832 the ratios are taken from Dr. A. Soetbeer; from 1833 to 1878 from Pixley and Abell's tables, and from 1879 to 1889 from daily cablegrams from London to the bureau of the mint.]

YEARS.	Ratio.	YEARS.	Ratio.	YEARS.	Ratio.	YEARS.	Ratio.	YEARS.	Ratio.	YEARS.	Ratio.
1687	14.94	1721	15.05	1755	14.68	1789	14.75	1823	15.84	1857	15.27
1688	14.94	1722	15.17	1756	14.94	1790	15.04	1824	15.82	1858	15.38
1689	15.02	1723	15.20	1757	14.87	1791	15.05	1825	15.70	1859	15.19
1690	15.02	1724	15.11	1758	14.85	1792	15.17	1826	15.76	1860	15.29
1691	14.98	1725	15.11	1759	14.15	1793	15.00	1827	15.74	1861	15.50
1692	14.92	1726	15.15	1760	14.14	1794	15.37	1828	15.78	1862	15.35
1693	14.83	1727	15.24	1761	14.54	1795	15.55	1829	15.78	1863	15.37
1694	14.87	1728	15.11	1762	15.27	1796	15.65	1830	15.82	1864	15.37
1695	15.02	1729	14.92	1763	14.99	1797	15.41	1831	15.72	1865	15.44
1696	15.00	1730	14.81	1764	14.70	1798	15.59	1832	15.73	1866	15.43
1697	15.20	1731	14.94	1765	14.83	1799	15.74	1833	15.93	1867	15.57
1698	15.07	1732	15.09	1766	14.80	1800	15.68	1834	15.73	1868	15.59
1699	14.94	1733	15.18	1767	14.85	1801	15.46	1835	15.80	1869	15.60
1700	14.81	1734	15.39	1768	14.80	1802	15.26	1836	15.72	1870	15.57
1701	15.07	1735	15.41	1769	14.72	1803	15.41	1837	15.83	1871	15.57
1702	15.52	1736	15.18	1770	14.62	1804	15.41	1838	15.85	1872	15.63
1703	15.17	1737	15.02	1771	14.66	1805	15.79	1839	15.62	1873	15.92
1704	15.22	1738	14.91	1772	14.52	1806	15.52	1840	15.62	1874	16.17
1705	15.11	1739	14.91	1773	14.62	1807	15.43	1841	15.70	1875	16.59
1706	15.27	1740	14.94	1774	14.62	1808	16.08	1842	15.87	1876	17.88
1707	15.44	1741	14.92	1775	14.72	1809	15.96	1843	15.93	1877	17.22
1708	15.41	1742	14.85	1776	14.55	1810	15.77	1844	15.85	1878	17.94
1709	15.31	1743	14.85	1777	14.54	1811	15.53	1845	15.92	1879	18.40
1710	15.22	1744	14.87	1778	14.68	1812	16.11	1846	15.90	1880	18.05
1711	15.29	1745	14.98	1779	14.80	1813	16.25	1847	15.80	1881	18.16
1712	15.31	1746	15.13	1780	14.72	1814	15.04	1848	15.85	1882	18.19
1713	15.24	1747	15.26	1781	14.78	1815	15.26	1849	15.78	1883	18.64
1714	15.13	1748	15.11	1782	14.42	1816	15.28	1850	15.70	1884	18.57
1715	15.11	1749	14.80	1783	14.48	1817	15.11	1851	15.46	1885	19.41
1716	15.09	1750	14.55	1784	14.70	1818	15.35	1852	15.59	1886	20.78
1717	15.13	1751	14.39	1785	14.92	1819	15.33	1853	15.33	1887	21.13
1718	15.11	1752	14.54	1786	14.96	1820	15.62	1854	15.33	1888	21.99
1719	15.09	1753	14.54	1787	14.92	1821	15.95	1855	15.38	1889	22.09
1720	15.04	1754	14.48	1788	14.65	1822	15.80	1856	15.38		

HIGHEST, LOWEST, AND AVERAGE PRICE OF BAR SILVER IN LONDON.

[Per ounce, British standard (0.925), since 1833, and the equivalent in United States gold coin of an ounce 1,000 fine, taken at the average price.]

CALENDAR YEARS.	Lowest quotation. (Pence.)	Highest quotation. (Pence.)	Average quotation. (Pence.)	Value of a fine ounce at average quotation.	CALENDAR YEARS.	Lowest quotation. (Pence.)	Highest quotation. (Pence.)	Average quotation. (Pence.)	Value of a fine ounce at average quotation.
1833	58.750	59.875	59.188	$1.297	1862	61.000	62.125	61.438	$1.346
1834	59.750	60.750	59.938	1.313	1863	61.000	61.750	61.375	1.345
1835	59.250	60.000	59.688	1.308	1864	60.625	62.500	61.375	1.345
1836	59.625	60.375	60.000	1.315	1865	60.500	61.625	61.063	1.338
1837	59.000	60.375	59.563	1.305	1866	60.375	62.250	61.125	1.339
1838	59.500	60.125	59.500	1.304	1867	60.375	61.250	60.563	1.328
1839	60.000	60.625	60.375	1.323	1868	60.125	61.125	60.500	1.326
1840	60.125	60.750	60.375	1.323	1869	60.000	61.000	60.438	1.325
1841	59.750	60.375	60.063	1.316	1870	60.250	60.750	60.563	1.328
1842	59.250	60.000	59.438	1.303	1871	60.188	61.000	60.500	1.326
1843	59.000	59.625	59.188	1.297	1872	59.250	61.125	60.313	1.322
1844	59.250	59.750	59.500	1.304	1873	57.875	59.938	59.250	1.298
1845	58.875	59.875	59.250	1.298	1874	57.250	59.500	58.313	1.278
1846	59.000	60.125	59.313	1.300	1875	55.500	57.625	56.875	1.246
1847	58.875	60.375	59.688	1.308	1876	46.750	58.500	52.750	1.156
1848	58.500	60.000	59.500	1.304	1877	53.250	58.250	54.813	1.201
1849	59.500	60.000	59.750	1.309	1878	49.500	55.250	52.563	1.152
1850	59.500	61.500	61.063	1.316	1879	48.875	53.750	51.250	1.123
1851	60.000	61.625	61.000	1.337	1880	51.625	52.875	52.250	1.145
1852	59.875	61.875	60.500	1.326	1881	50.875	52.875	51.938	1.138
1853	60.625	61.875	61.500	1.348	1882	50.000	52.375	51.813	1.136
1854	60.875	61.875	61.500	1.348	1883	50.000	51.188	50.625	1.110
1855	60.000	61.625	61.313	1.344	1884	49.500	51.375	50.750	1.113
1856	60.500	62.250	61.313	1.344	1885	46.875	50.000	48.563	1.065
1857	61.000	62.375	61.750	1.353	1886	42.000	47.000	45.375	0.995
1858	60.750	61.875	61.313	1.344	1887	43.250	47.125	44.625	0.978
1859	61.750	62.750	62.063	1.360	1888	41.625	44.563	42.875	0.940
1860	61.250	62.375	61.688	1.352	1889	42.000	44.375	42.688	0.936
1861	60.125	61.375	60.813	1.333					

IMPORTS AND EXPORTS OF THE PRECIOUS METALS.

The collection of statistics of the imports and exports of the precious metals, their uses in coinage and in the arts, and the stock of precious metals in this and foreign countries, are subjects that come in the immediate department of the director of the mint, and from his admirable reports the following information has been condensed:

GOLD.

The value of the foreign gold bullion imported into the United States during the calendar year 1889 was $1,679,999. Of this, $490,336 came from the British possessions in North America, $185,560 from Australasia, and the balance from South and Central American countries.

In addition to imports of foreign gold bullion, gold ores of the invoiced value of $56,888 were brought into this country for reduction, all except a small amount coming from Mexico and Colombia.

Foreign gold coins were imported of the value of $8,387,933, of which $3,767,392 were from Australasia, $1,459,861 from France, $1,630,073 from Germany, $370,828 from England, $318,832 from Mexico, $607,508 from Cuba, $141,247 from Colombia, and the remainder from various countries, principally of South America.

United States gold coins were imported during the year of the value of $1,936,700.

GOLD IMPORTS IN 1889.

Foreign bullion	$1,679,999
Foreign coin	8,387,933
Foreign ores	56,888
Total foreign	10,124,820
United States coin	1,936,700
Total imports	12,061,520

There was exported from the United States during the calendar year domestic gold bullion of the value of $40,518,521, of which $39,402,004 consisted of United States bars and $1,116,517 of other bars and bullion.

Of the gold bars exported, $27,692,855 went to France, $12,795,575 to England, $17,800 to Germany, and $12,291 to Hongkong.

Foreign gold bullion of the value of $12,600 was re-exported to England, and foreign gold ores of the value of $1,952 to Germany and England, while domestic gold and silver ores were exported of the value of $12,861, mostly to Germany.

Native gold coin was exported to the value of $4,784,976, of which $2,528,326 went to Venezuela, the remainder going to Hongkong, Hayti, San Domingo, the Hawaiian Islands, and other countries, principally of South and Central America, but a trifling amount going to Europe.

Foreign gold coins were re-exported of the value of $5,617,363, of which $4,367,312 went to Cuba, $886,307 to England, $258,790 to Brazil, and the remainder to various countries, principally of South America.

GOLD EXPORTS IN 1889.

United States bars		$39,402,004
Other domestic bullion		1,116,517
Domestic coin		4,784,976
Domestic ores		12,861
Total domestic		45,316,358
Foreign bullion re-exported	$12,600	
Foreign coin re-exported	5,617,363	
Foreign ores re-exported	1,952	
Total foreign		5,631,915
Total gold exports		50,948,273

From the above totals it will be seen that there was a net loss of gold to the United States during the year by excess of exports over imports of the value of $38,886,753.

SILVER.

The commercial value of the foreign silver bullion imported into the United States during the calendar year, as registered at the customhouses, was $5,453,534. This bullion consisted of unparted bars, the bulk of it, $4,636,174, coming from Mexico, $736,304 from Colombia, $16,623 from the British possessions in North America, and the remainder principally from states of Central America.

In addition to the imports of foreign silver bars, silver ores were imported into the United States for reduction of the invoiced value of $7,584,715. The bulk of these ores also came from Mexico, the invoiced value from that country being $7,381,513; $161,084 from the British possessions in North America, and the remainder principally from countries of South and Central America. Most of these ores were what are known as silver-lead ores, containing, in addition to silver, large quantities of metallic lead, with some little gold and copper.

APPROXIMATE STATEMENT OF THE QUANTITIES AND VALUES OF SILVER ORES IMPORTED INTO THE UNITED STATES DURING THE CALENDAR YEAR 1889.

Customs districts.	Total ore. (Pounds.)	Lead contained.		Copper contained.		Commercial value of silver contained.	Value of gold contained.	Total value.
		Quantity. (Pounds.)	Value.	Quantity. (Pounds.)	Value.			
Total	241,494,307	53,166,802	$1,001,473	280,573	$14,273	$6,722,086	$59,406	$7,797,238
Boston and Charlestown, Massachusetts						2,000		2,000
Corpus Christi, Texas	44,506,698	6,221,390	52,253			1,125,506	33,179	1,210,938
Duluth, Minnesota	28,800					7,800		7,800
Minnesota, Minnesota	27,730					15,000		15,000
New Orleans, Louisiana	1,076,764					42,161	5,800	47,961
New York, New York		27,569				497,685		497,685
Omaha, Nebraska	33,644					1,750		1,750
Oswegatchie, New York	161,540					118,230		118,230
Paso del Norte, Texas and New Mexico	140,116,091	32,622,256	761,322	280,573	14,273	3,729,591	2,901	4,508,087
Saluria, Texas	55,543,040	14,295,587	187,898			626,644	17,526	832,068
San Francisco, California						555,719		555,719

Foreign silver coins were imported into the United States of the value of $13,579,782, of which $12,637,296 were Mexican dollars, the remainder coming from various countries, mainly South and Central America.

United States silver coins, principally subsidiary pieces, were imported of the value of $185,946.

The total imports of silver into the United States during the year may be recapitulated as follows:

IMPORTS OF SILVER IN 1889.

Foreign bullion (commercial value)	$5,453,534
Silver in foreign ores (commercial value)	6,722,086
Foreign silver coin	13,579,782
Total foreign	25,755,402
United States silver coin (subsidiary)	185,946
Total silver imports	25,941,348

There was exported from the United States during the calendar year domestic silver bullion of the commercial value of $27,068,531, of which $766,777 consisted of bars bearing the stamp of a United States mint or assay office, the remainder being bars of private refineries.

Of the silver bullion exported from the United States $18,092,735 went to London, $3,422,500 to Hongkong, $3,394,900 to Japan, $1,324,784 to the East Indies, $221,660 (for refining) to Germany, and the remainder principally to South and Central America.

Foreign silver bullion was re-exported of the value of $116,684, all going to London, and foreign silver ores of the value of $35,784, together with domestic gold and silver ores of the value of $12,861. Foreign silver coin was re-exported of the value of $13,385,867, most of which consisted of Mexican dollars, of which $9,281,871 went to Hongkong and $2,471,949 to London. United States silver coin of the value of $123,148 was exported. The exports of silver during the year may be recapitulated as follows:

EXPORTS OF SILVER IN 1889.

United States bars (commercial value)		$766,777
Domestic bullion (commercial value)		26,301,754
United States silver coin		123,148
Total domestic		27,191,679
Foreign silver coin, re-exported	$13,385,867	
Silver, in foreign ores, re-exported	35,784	
Foreign silver bullion re-exported	116,684	
Total foreign		13,538,335
Total silver exports		40,730,014

The above totals show that there was a net loss of silver to the United States during the year of $14,788,666.

COINAGE DURING THE CALENDAR YEAR 1889.

The coinage executed during the calendar year 1889 at the 4 coinage mints, viz, at Philadelphia, San Francisco, New Orleans, and Carson City, aggregated 109,140,917 pieces, bearing the face value of $58,194,022.64.

UNITED STATES COINAGE, CALENDAR YEAR 1889.

DESCRIPTION.	Pieces.	Value.
Total	109,140,917	$58,194,022.64
Gold	1,338,012	21,413,931.00
Silver dollars	34,651,811	34,651,811.00
Subsidiary silver coins	8,378,811	844,872.15
Minor coins	64,772,283	1,283,408.49

WORLD'S COINAGE.

CALENDAR YEARS.	Gold.	Silver, coining value.
1887	$124,992,465	$163,411,397
1888	134,827,740	134,922,344
1889	167,731,286	132,280,659

The aggregate amount of coinage each year does not correctly represent the value of the annual product of gold and silver employed in coinage, for the reason that the coinages reported include recoinages of both domestic and foreign coin, as well as old material employed in coinage.

The data covering the recoinages of the calendar year 1889 are not sufficiently complete to afford any fair presentation of the amount of old coins melted down.

In addition to the coinage executed, bars of gold and silver were manufactured at the United States mints and assay offices to the value of $28,572,503.37, as follows:

Gold	$22, 349, 752. 28
Silver	6, 222, 751. 09
Total	28, 572, 503. 37

GOLD AND SILVER USED IN THE INDUSTRIAL ARTS IN THE UNITED STATES.

Inquiry has been prosecuted for the purpose of ascertaining the amount and value of the precious metals used in the industrial arts in this country during the calendar year 1889. These inquiries have been confined to ascertaining from government institutions and from private refineries the amount and value of the bars of gold and silver furnished to jewelers and manufacturers for industrial use.

The following table is a summary of the work of government and private institutions in the preparation of bars for industrial use during the calendar year 1889:

VALUE OF GOLD AND SILVER BARS FURNISHED FOR USE IN MANUFACTURES AND THE ARTS DURING THE CALENDAR YEAR 1889.

MATERIAL.	Total.	Gold.	Silver.
Total	$22, 193, 253	$13, 623, 935	$8, 569, 318
United States coin	429, 252	426, 879	2, 373
Domestic bullion	16, 984, 760	9, 686, 827	7, 297, 933
Foreign coin and bullion	949, 255	291, 258	657, 997
Old material	3, 829, 986	3, 218, 971	611, 015

The amount of domestic bullion used in the composition of jewelers' bars was: gold, $9,686,827; silver, $7,297,933, the latter corresponding to 6,090,496 fine ounces of silver, worth at the average price of silver for the calendar year about $5,701,000.

The amount of United States gold coin reported as having been melted for use in the manufacture of bars for industrial purposes during the calendar year 1889 was $426,879, against an estimated annual melting down of United States gold coin for industrial use, based on 4 censuses of actual consumption taken by the mint bureau, of $3,500,000.

Unless, therefore, there has been a decided falling off in the melting down of coin for industrial purposes by jewelers and others, the value of the precious metals used in the industrial arts in the United States during the calendar year 1889 approximated $16,697,000 gold and $8,766,000 silver (coining value).

In the report of the Tenth Census the estimated consumption of gold and silver in the industrial arts for the fiscal year ended June 30, 1880, was, gold, $10,000,000, and silver, $5,000,000.

SILVER PURCHASES BY THE UNITED STATES GOVERNMENT.

The quantity of silver delivered during the calendar year 1889 on purchases for the coinage of the standard silver dollar under the requirements of the act of February 28, 1878, was 27,125,357.61 fine ounces, costing $25,379,510.60, an average cost of $0.935638 per fine ounce.

MONTHLY PURCHASE AND COINAGE INTO SILVER DOLLARS DURING THE CALENDAR YEAR 1889.

MONTHS.	Average price per fine ounce for previous month.	Number of fine ounces required to procure $2,000,000 worth of bullion.	Coining value in silver dollars.	Dollars coined.	Bullion contained. (Standard ounces.)	Cost of bullion coined.
Total	....	25, 670, 066	$33, 189, 578	34, 651, 811	29, 778, 900. 06	$25, 028, 050. 29
January	$0. 93581	2, 137, 186	2, 763, 230	3, 100, 000	2, 664, 062. 50	2, 247, 315. 04
February	0. 93616	2, 136, 387	2, 762, 197	2, 710, 300	2, 329, 164. 06	1, 962, 858. 15
March	0. 93752	2, 133, 288	2, 758, 190	3, 000, 025	2, 578, 146. 48	2, 171, 613. 57
April	0. 93652	2, 135, 566	2, 761, 136	2, 978, 000	2, 559, 218. 75	2, 149, 502. 65
May	0. 92918	2, 152, 435	2, 782, 946	3, 164, 025	2, 719, 083. 98	2, 278, 333. 80
June	0. 92893	2, 153, 015	2, 783, 696	3, 264, 110	2, 805, 094. 53	2, 346, 048. 43
July	0. 92547	2, 161, 064	2, 794, 103	1, 300, 000	1, 117, 187. 50	932, 485. 09
August	0. 92638	2, 158, 941	2, 791, 358	2, 875, 000	2, 470, 703. 13	2, 062, 129. 23
September	0. 92659	2, 151, 486	2, 781, 719	2, 860, 000	2, 457, 812. 50	2, 054, 448. 71
October	0. 93477	2, 139, 564	2, 766, 305	3, 100, 351	2, 664, 364. 13	2, 233, 123. 36
November	0. 94036	2, 126, 845	2, 749, 860	3, 300, 000	2, 835, 937. 50	2, 392, 960. 11
December	0. 95556	2, 084, 289	2, 694, 838	3, 000, 000	2, 578, 125. 00	2, 197, 232. 15

HIGHEST, LOWEST, AND AVERAGE PRICE IN LONDON OF SILVER BULLION 0.925 FINE, AND VALUE OF A FINE OUNCE EACH MONTH DURING THE CALENDAR YEAR 1889.

MONTHS.	Highest. (Pence.)	Lowest. (Pence.)	Average price per ounce 0.925 fine British standard. (Pence.)	Equivalent value of a fine ounce with exchange at par, $4.8665.	Average monthly price at New York of exchange on London.	Equivalent value of a fine ounce, based on average monthly price and average rate of exchange.	Average monthly New York price of fine bar silver.
Average	....	....	42.659—	$0.93533—	$4.8757+	$0.93695—	$0.93631+
January	42.688	42.375	42.544	0.93261	4.8810	0.93616	0.93644
February	42.750	42.500	42.594	0.93371	4.8872	0.93752	0.93750
March	42.625	42.250	42.521	0.93211	4.8894	0.93652	0.93769
April	42.313	42.125	42.185	0.92474	4.8895	0.92918	0.92865
May	42.250	41.938	42.162	0.92424	4.8900	0.92893	0.92865
June	42.188	42.000	42.034	0.92143	4.8879	0.92547	0.92595
July	42.313	42.000	42.159	0.92417	4.8776	0.92638	0.92558
August	42.563	42.250	42.349	0.92834	4.8731	0.92959	0.92843
September	42.688	42.375	42.522	0.93213	4.8798	0.93477	0.92589
October	43.500	42.625	42.944	0.94382	4.8612	0.94036	0.94120
November	44.375	43.625	43.923	0.96284	4.8500	0.95956	0.96100
December	44.375	43.750	43.967	0.96381	4.8419	0.95894	0.95880

STOCK OF MONEY IN THE UNITED STATES.

In view of the wide difference between the estimated and the visible stock of gold coin, the presumption is almost conclusive that either gold coin has left the country without being recorded or a very large amount is hoarded by the people of the United States in the shape of keepsakes and private savings.

The following table has been compiled from the latest data attainable for the purpose of exhibiting by way of comparison the stock of gold, silver, and paper money in circulation in the United States and in the 3 principal countries of Europe:

ESTIMATED AMOUNT OF GOLD, SILVER, AND NOTES IN CIRCULATION IN FRANCE, THE UNITED KINGDOM, GERMANY, AND THE UNITED STATES.

COUNTRIES.	Population.	Total metallic and paper.	Gold circulation.	Silver circulation.	Notes outstanding.	PER CAPITA CIRCULATION.			
						Total.	Gold.	Silver.	Paper.
France	38,219,000	$2,194,000,000	$900,000,000	$700,000,000	$594,000,000	$57.41	$23.55	$18.32	$15.54
United Kingdom	38,166,000	840,000,000	550,000,000	100,000,000	190,000,000	22.01	14.41	2.62	4.98
Germany	49,423,000	990,000,000	500,000,000	215,000,000	275,000,000	20.03	10.12	4.35	5.56
United States	62,653,000	1,430,634,459	375,607,112	116,298,802	938,728,545	22.83	5.99	1.86	14.98

In compiling this table the metallic reserves of the Bank of the United Kingdom, the Bank of France, and the Imperial Bank of Germany have been included in the amount of gold and silver in circulation, and the total bank notes outstanding in the amount of paper money in circulation, whereas in the United States the entire amount of gold and silver in the Treasury has been deducted.

In European statistics of circulation it is customary to deduct from the bank notes in circulation the metallic reserves held by the banks for their redemption against which the notes are issued, and to class as in circulation only the "uncovered" bank notes. This is done to prevent double employment, as both the notes issued and the specie held for their redemption do not perform the duty of a circulating medium at the same time. Following this method, which is that used by Dr. Soetbeer and other European statisticians, the following table has been compiled showing the amount of metallic money and "uncovered" notes in 3 of the principal countries of Europe and in the United States:

STOCK OF GOLD, SILVER, AND UNCOVERED NOTES IN FRANCE, THE UNITED KINGDOM, GERMANY, AND UNITED STATES.

COUNTRIES.	Population.	Total metallic and uncovered stock.	Gold stock.	Silver stock.	Uncovered notes.	PER CAPITA.			
						Total.	Gold.	Silver.	Paper.
France	38,219,000	$1,704,000,000	$900,000,000	$700,000,000	$104,000,000	$44.59	$23.55	$18.32	$2.72
United Kingdom	38,166,000	710,000,000	550,000,000	100,000,000	60,000,000	18.60	14.41	2.62	1.57
Germany	49,423,000	865,000,000	500,000,000	215,000,000	150,000,000	17.50	10.12	4.35	3.03
United States	62,653,000	1,560,457,214	689,275,007	438,388,624	432,793,583	24.91	11.00	7.00	6.91

In the preceding table the gold certificates outstanding are embraced in the gold stock and the silver certificates in the silver stock, and both amounts have been deducted from the amount of paper money outstanding.

From the legal-tender notes outstanding has been deducted $100,000,000 of gold coin held in the Treasury for their redemption, leaving as the amount of "uncovered" paper money in the United States $231,007,091 legal-tender notes, $192,730,050 national-bank notes, $9,000,000 certificates of deposit for legal-tender notes, and $56,442 "old demand" notes, a total of $432,793,583.

The following table exhibits the estimated stock of metallic and representative money in the United States and the location of the same January 1, 1890:

LOCATION OF THE MONEYS OF THE UNITED STATES, JANUARY 1, 1890.

MONEYS.	Total.	In Treasury.	In national banks (December 11, 1889).	In other banks and general circulation.
METALLIC.				
Total	$1,127,663,631	$635,757,717	$82,459,193	$409,446,721
Gold bullion	67,265,944	67,265,944		
Silver bullion	11,626,395	11,626,395		
Gold coin	622,009,063	246,401,951	71,910,467	303,696,645
Silver dollars	349,938,001	288,535,500	6,459,483	54,943,018
Subsidiary silver coin	76,824,228	21,927,927	4,089,243	50,807,058
PAPER.				
Total	993,041,891	54,313,346	205,101,229	733,627,316
Legal-tender notes	346,681,016	*a*15,673,925	84,490,894	246,516,197
Old demand notes	56,442			56,442
Certificates of deposit	9,570,000	570,000	9,000,000	
Gold certificates	154,301,989	31,316,100	77,408,260	45,577,629
Silver certificates	285,202,039	2,252,966	11,422,004	271,527,069
National-bank notes	197,230,405	*b*4,500,355	*c*22,780,071	169,949,979

a Includes $9,000,000 held for redemption of certificates of deposit for legal-tender notes, act of June 8, 1872.
b Includes $4,367,102 in process of redemption.
c Includes $2,391,264 of their own notes held by the different national banks.

The ownership, as distinguished from the location, of the estimated stock of United States gold and silver coin and bullion is exhibited in the following table:

OWNERSHIP OF GOLD AND SILVER IN THE UNITED STATES, JANUARY 1, 1890.

OWNERSHIP.	Total gold and silver coin and bullion.	Gold coin and bullion.	SILVER COIN AND BULLION. Total silver.	Silver dollars.	Subsidiary silver coin.	Silver bullion.
Total	$1,127,663,631	$689,275,007	$438,388,624	$349,938,001	$76,824,228	$11,626,395
United States treasury	229,822,755	*a*190,682,006	39,140,749	*b*5,586,427	21,927,927	11,626,395
National banks (December 11, 1889)	171,089,457	*c*149,318,727	21,770,730	*d*17,681,487	4,089,243	
Banks other than national (gold-coin holdings reported to director of the mint).	726,751,419	31,212,417	377,477,145	326,670,087	50,807,058	
Banks other than national (not reporting) and in private hands		318,061,857				

a Gold coin in the Treasury and gold bullion in the mints and assay offices, exclusive of $122,985,889 gold certificates outstanding.
b Silver dollars in the Treasury, exclusive of $282,949,073 silver certificates outstanding.
c Includes Treasury and clearing-house gold certificates, $77,408,260.
d Includes Treasury silver certificates, $11,222,004.

COMPARISON OF THE OFFICIAL TABLES OF THE STOCK OF GOLD COIN WITH THE VISIBLE STOCK, JANUARY 1, 1890.

United States gold coin		$622,009,063
Gold bullion in mints and assay offices		67,265,944
		689,275,007
Visible stock:		
Gold coin in United States treasury and branches	$246,401,951	
Gold bullion	67,265,944	
In national banks	71,910,467	
In other banks	34,000,000	
Total visible stock		419,578,362
Difference		269,696,645

In this statement are included hoardings and other uses withdrawing the coin from circulation.

COINAGES OF NATIONS.

The amount of gold and silver coined by each country varies greatly from year to year, but as showing the amount coined in each of the past 10 years the following table has been compiled from successive reports of the director of the United States mint. This coinage includes also recoinage from old coins.

COINAGES OF VARIOUS NATIONS.

COUNTRIES.	1880.		1881.		1882.		1883.	
	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.
Total	$149,645,236	$82,397,154	$147,015,275	$108,010,086	$99,697,170	$110,785,934	$104,845,114	$109,306,705
United States	62,308,279	27,409,706	96,850,890	27,939,203	65,887,685	27,972,035	29,241,990	29,245,989
Mexico			438,778	24,139,023	452,590	25,146,260	407,600	24,083,921
Great Britain	20,196,228	3,705,878		4,852,523		1,021,381	6,831,169	6,201,517
Australia	22,151,334		19,699,115		18,701,959		19,903,722	
India (a)	69,670	40,002,173		20,682,625	170,543	29,386,322	67,044	24,927,400
Canada								
France			418,231	1,299,554	722,206	223,853		
Roumania				4,747,800				
Cochin China								
Monaco								
Belgium		150,639		38,055	2,016,117			
Italy	499,997		3,253,988	1,598,346			785,027	
Switzerland							965,000	
Spain	33,113,719	268,955	21,067,127	3,080,193	1,996,310	10,671,842	3,327,235	10,523,421
Portugal	348,765	145,492	245,160		162,000		217,080	
Netherlands	259,313	40,200				608,312		81,095
Germany	6,662,153		1,634,189		3,167,085	6,407,157	21,002,897	594,564
Austria-Hungary (b)	2,468,029	8,373,563	2,429,998	9,028,671	2,829,590	3,122,819	2,154,390	5,552,191
Norway		499		28,930		69,680	192,708	37,520
Sweden	752,992	223,094	340,275	290,137	39,876	17,707	436,619	250,468
Denmark								
Russia (c)							12,793,575	
Turkey					2,960,056		1,344,640	44,000
Siam								
Egypt								
Japan	460,365	2,076,955	490,585	4,514,043	565,645	4,367,393	544,290	3,120,892
Hayti				780,000				
Chile			125,280	3,020,000				
Argentine Republic							4,530,210	1,715,445
Peru								
Persia							47,117	605,579
Colombia								699,114
Venezuela	324,024							
Guatemala								
Brazil	30,368		21,659		25,508	9,994	52,801	23,589
Honduras						76,314		
Congo								
Nicaragua								
Straits Settlements								
Hawaiian Islands								
Ecuador								
Hongkong								
Costa Rica								
Bolivia				1,970,983		1,684,865		1,600,000

a Rupee calculated at coining rate, $0.4737. b Silver florin calculated at coining rate, $0.4820. c Silver ruble calculated at coining rate, $0.7718.

COINAGES OF VARIOUS NATIONS—Continued.

COUNTRIES.	1884.		1885.		1886.	
	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.
Total	$99,432,795	$95,832,084	$95,757,582	$126,764,574	$94,642,070	$124,854,101
United States	23,991,756	28,534,866	27,773,012	28,962,176	28,945,542	32,086,709
Mexico	328,698	25,377,378	423,250	25,840,727	367,490	26,991,804
Great Britain	11,309,819	3,204,824	14,366,677	3,540,719		2,031,194
Australia	22,196,106		21,694,857		22,524,595	
India (a)		17,353,531	106,987	48,487,114		27,121,414
Canada						225,000
France		23,160	55,854		4,455,733	29,795
Roumania						
Cochin China		120,000		1,279,511		3,215,771
Monaco			164,648		289,500	
Belgium						921,768
Italy	62,165	2,121,953	635,873	230,831	227,771	1,795,364
Switzerland					965,000	501,800
Spain	4,983,004	6,738,971	2,435,108	3,678,314	2,369,765	5,057,506
Portugal	186,840		246,240		179,626	299,765
Netherlands		182,910	280,000	80,400	217,647	
Germany	13,723,494	114,319	1,939,443	577,664	8,506,210	1,153,963
Austria-Hungary (b)	2,444,004	4,987,781	2,791,958	4,147,659	2,684,139	4,384,433
Norway				53,600	539,484	
Sweden	1,022,420	132,784	33,500	78,281	982,188	
Denmark						13,624
Russia (c)	18,615,074	1,238,746	20,685,852	964,769	14,761,717	1,304,101
Turkey					3,652,000	880,000
Siam						
Egypt						3,204,151
Japan	569,415	3,599,912	1,004,005	6,320,927	900,165	9,086,077
Hayti						144,750
Chile			77,580	564,080	37,210	966,080
Argentine Republic			984,000		1,988,670	
Peru		1,400,949		1,326,266		592,065
Persia						
Colombia					26,965	1,354,826
Venezuela						1,286,345
Guatemala						27,387
Brazil			58,738	12,090	20,653	30,373
Honduras				106,510		
Congo						
Nicaragua				400,000		
Straits Settlements						
Hawaiian Islands		700,000				
Ecuador						
Hongkong						
Costa Rica				112,936		148,036
Bolivia						

a Rupee calculated at coining rate, $0.4737. b Silver florin calculated at coining rate, $0.4820. c Silver ruble calculated at coining rate, $0.7718.

COINAGES OF VARIOUS NATIONS—Continued.

Countries.	1887.		1888.		1889.	
	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.
Total	$124,992,465	$163,411,397	$134,828,855	$134,922,344	$168,901,519	$138,444,595
United States	23,972,383	35,191,081	31,380,808	33,025,606	21,413,931	35,496,683
Mexico	398,647	26,844,031	300,480	26,658,964	319,907	25,294,726
Great Britain	9,728,498	4,142,136	9,893,375	3,681,886	36,502,536	10,827,602
Australia	24,122,267		24,415,230		29,325,529	
India (a)	4,249	44,142,013	108,216	36,297,132	110,328	37,937,814
Canada		85,000		247,174		16,585
France	4,760,960	1,719,742	106,949	1,112,379	3,273,215	71
Roumania						
Cochin China		3,126,410		1,100,518		1,302,581
Monaco						
Belgium		583,632				
Italy		6,253,200	469,750			60,208
Switzerland		270,200	16,984		386,000	217,125
Spain		11,389,414		4,436,804	3,378,631	4,716,029
Portugal	270,000	960,120	102,600	1,533,600	96,120	680,400
Netherlands	163,831	76,380	143,051		823,943	132,660
Germany	28,135,270	715,343	34,340,722	989,127	48,166,245	177,079
Austria-Hungary (b)	2,669,750	5,556,395	2,747,633	5,516,190	3,294,987	4,528,259
Norway		80,400		53,600		53,600
Sweden	314,830	56,082		16,714	1,080,040	142,253
Denmark				62,483		27,667
Russia (c)	20,109,276	1,551,710	20,460,491	1,163,126	18,855,097	1,153,651
Turkey			66,000	74,448		
Siam		2,216,065				1,446,620
Egypt	246,354	2,159,690	257,154	8,483		
Japan	897,420	10,279,555	974,335	10,222,108	1,775,010	9,516,359
Hayti		500,000				
Chile	25,360	333,000	42,170	122,375		
Argentine Republic	9,173,370		8,316,325			
Peru		1,685,000		3,258,000		2,842,531
Colombia		663,069		600,443		216,136
Venezuela			660,500	272,000		
Brazil			26,082	883,555		
Honduras		71,978				
Congo		19,300				
Nicaragua		400,000				
Straits Settlements		177,000		244,000		300,000
Hawaiian Islands						
Ecuador				473,177		
Hongkong		400,000		1,105,000		1,100,000
Costa Rica						258,010
Bolivia		1,763,451		1,763,452		

a Rupee calculated at coining rate, $0.4737.　b Silver florin calculated at coining rate, $0.4820.　c Silver rouble calculated at coining rate, $0.7718.

AGGREGATE COINAGE OF THE PRINCIPAL COUNTRIES.

The following table (from the British report of 1887) gives the aggregate gold and silver coinage of the United States, England, Germany, Russia, France, Belgium, Italy, Austria, and India (which latter, however, coined only silver in each year from 1852 to 1885) stated in millions of pounds sterling:

YEARS.	Gold.	Silver.	YEARS.	Gold.	Silver.
1852	21.8	9.1	1869	26.7	12.5
1853	32.8	9.7	1870	16.6	17.1
1854	30.8	7.9	1871	21.9	9.0
1855	33.8	3.8	1872	45.1	7.9
1856	35.3	11.0	1873	45.0	20.1
1857	32.4	13.4	1874	27.3	13.4
1858	37.7	21.1	1875	35.2	20.6
1859	39.2	17.9	1876	37.6	23.2
1860	28.6	19.7	1877	38.9	18.9
1861	27.0	12.9	1878	37.8	28.1
1862	32.5	12.2	1879	21.0	20.8
1863	28.3	12.6	1880	26.6	19.5
1864	33.4	15.6	1881	26.2	14.1
1865	22.8	15.4	1882	33.7	10.0
1866	32.6	21.2	1883	21.2	16.3
1867	21.0	17.5	1884	19.2	12.2
1868	25.3	13.5	1885	17.4	14.3

CONDITION OF THE METALLURGY OF GOLD AND SILVER IN 1889, FROM EXAMPLES IN SUCCESSFUL OPERATION.

A scientific investigation of the technical condition of the gold and silver industry has not been attempted, yet it has seemed so important that this report should place on record the present condition of the metallurgy of gold and silver that herewith are given some of the best monographs on the latest successful practice in gold milling. These are: a general paper giving the present condition of the metallurgy of gold, by Mr. C. H. Aaron; a paper describing the most advanced and successful application of barrel chlorination of gold ores, by Mr. John E. Rothwell; a paper giving two examples of the cheapest recorded mining and milling of gold ore in 1889 and 1890; and, finally, a description of Mr. Gutzkow's method for refining silver bullion, which is now in successful operation at several large works in the United States. These papers, prepared by men who are successfully carrying out the processes they describe, represent in concise form the most improved practice in gold metallurgy and show the state of the art at the present time.

GOLD MINING.

The following notes on gold milling were contributed by Mr. C. H. Aaron, metallurgist, to the Engineering and Mining Journal, New York, August 10, 1889:

These notes are based partly on the writer's own observation and experience, partly on information received privately, and partly on a late report of the state mineralogist of California.

In many gold quartz mills no attempt is made to ascertain the true gold content per ton of the rock crushed; consequently the proportions of recovery and loss are not known. This seems to be due in part to the conceit of some mill men, who imagine that what they fail to save can not be saved, and in part to an idea that it is not possible to obtain samples of gold rock which will correctly represent the average. The question of individual skill and ability is beyond discussion, and the writer admits that the average loss of free gold and, where concentrators are used, of gold in sulphurets also, is below the estimate of many writers and workers, some of whom put it as high as 30 per cent; but it is admitted by all that there is a loss, and the reduction of that to the lowest possible limit, consistent with the object in view, which is profit, should be the subject of constant endeavor, and the most likely thing to promote such endeavor is an exact knowledge of the extent of the loss in percentage of the original content of the rock. The absolute loss per ton is easily ascertained by the assays of tailings, of which correct samples can readily be taken, but, in order to reduce this to percentage, it is necessary to know the weight and value per ton of the rock crushed. This is not so difficult as many suppose. In some cases, that is, where the gold is distributed in extremely small particles through the gangue, samples of gold rock can be taken, before it goes into the battery, with the same facility as in the case of smelting ores. Samples should be taken in measured quantity every hour from the feeders, or from the breakers, and the accumulation of each 24 hours well mixed, crushed by a small breaker, reduced by quartering to the proper extent, and the resulting quantity passed through a fine sieve for assay. Any coarse gold that may refuse the sieve must be separately estimated and the assay of the powder corrected in the usual way, as explained in works on assaying. Samples thus taken at the Bunker Hill mine during 5 years have not varied more than 10 cents per ton from the milling results. The free gold recovered and the gold contained in the concentrates and tailings correspond invariably to the monthly battery samples. In case the rock contains a considerable proportion of coarse gold, the battery samples will be unreliable, and the required information must be obtained in a different way. The weight of the tailings equals that of the ore crushed, except where concentration is practiced, in which case it is only necessary to deduct from the known weight of rock crushed that of the concentrates in order to obtain the weight of the final tailings. If now the tailings are properly sampled and assayed, and their total value for a given period is added to that of the amalgam and of the concentrates for the same period, we shall have all the data necessary for calculating the percentage of loss in the crushing. The subsequent loss in treating the concentrates is another matter. It will, of course, be necessary to weigh the ore which is sent to the mill, and to correct the weight for moisture in case the rock is not dry. This is a very easy matter if proper arrangements are made.

By free gold is meant gold which, originally inclosed in the gangue, has been or might have been released by mechanical means, and, while including such gold as, though imbedded in galena and other sulphurets, can be released by crushing the inclosing substance, excludes that portion of the metal which exists in the sulphurets in such a condition as to be practically incapable of amalgamation in the batteries or on the plates. The first thing to be ascertained is how much of the gold is being carried off in the tailings. There should be a systematic weighing of the rock crushed in each run and sampling of the tailings, both of which can and should be done automatically. The concentrates must be also weighed and a correct sample taken and sealed in a bottle, in order that the percentage of water and the gold value per ton may be ascertained. The sample, with a statement of the value of free gold saved, the weight of ore crushed, and the weight of the concentrates, should be sent to a competent assayer, and he will report the value per ton of the ore worked and the percentage lost. Next an investigation should be made as to the manner and causes of the loss, as a guide to the direction in which to seek such remedy. Among these causes are or may be the following:

FLOTATION.

The loss from this will increase, first, with the fineness of the golden particles; second, in absolute quantity, though not in percentage of the whole, with the richness of the rock in such fine particles; third, in percentage, though not in absolute quantity, with the poverty of the rock in such gold; fourth, with the quantity of water used; fifth, with the muddiness of the water; hence a just medium must be found in this respect by trial, so much water being applied as to dilute the mud as far as possible without causing much of the gold to be swept away by the too forcible current. In this connection the inclination of the plates must be considered, and it seems probable that Gauthier's shaking apron will be found very useful by allowing less inclination with a given quantity of water, or less water with a given inclination. Sixth, on the degree to which the coarser particles of gold and the amalgam are abraded and comminuted by the stamps, which indicates that the prevalent practice of amalgamating as much as possible in the mortars, by means of fine screens, high discharge, and a minimum of water in the battery, with a proportionately greater addition on the plates, may not always be the best, and that the grinding action claimed for revolving stamps may not be an advantage.

INCLOSURE IN PARTICLES OF GANGUE.

Evidently there is no remedy for this but finer crushing; but a consideration of the causes of loss in the preceding paragraph will show that there is a limit in practice to the fineness to which the ore can be crushed in one operation with advantage, for the finer it is crushed the more will the particles of gold be comminuted, as well as the rock, and the more will the settling of the gold to a contact with the amalgamated plates be obstructed by the fine particles of rock with which the water will be charged to excess. This suggests that it might, in some cases, be found advantageous to submit the rock to two distinct operations of crushing and amalgamation, with an intermediate separation of slimes. This is done, in effect, at the Plumas-Eureka mine, where the tailings from the mill are taken up by Italians, who pay a royalty for the privilege, and passed into wide, shallow boxes, which retain the sand while the slimes pass on. The sands are then ground and amalgamated in arrastres driven by water power. There are about 30 arrastres thus occupied on the tailings from that mill.

INAPTNESS OF THE GOLD TO AMALGAMATE.

The difficulty occasionally met with in causing the gold to unite with the quicksilver is sometimes due to a film of iron oxide or other substance which envelopes the auriferous grains. This is notably the case with the gold in beach sand, which sometimes obstinately refuses amalgamation until cleaned by chemical or mechanical means. When gold in quartz is in this condition it may be benefited by a certain amount of grinding, but it seems probable that the difficulty is sometimes caused by the quality of the water used. Mr. William Skey has made a study of this subject, and he has said that the presence of iron sulphate in the water is injurious to amalgamation, and iron sulphate is often to be found in the water coming from a mine, which is sometimes used in the battery. It has been proved that gold which has been hammered does not amalgamate well, and especially when hammered in the presence of quartz or other matter, particles of which then adhere to the metal and prevent the contact of quicksilver, which is another argument in favor of two or more separate crushing and amalgamating operations. The temperature of the water used has a considerable influence, and in some mills the water for the batteries is warmed artificially in cold weather. Also some drift gravel mines suspend operations during the winter for the same reason. In one instance, at least, it has been found advantageous to allow a small steam of solution of potassium cyanide to flow constantly into the battery, and I think it would be still better if some red oxide of mercury were dissolved in the cyanide solution. In such a liquid every particle of gold becomes coated with quicksilver. I have found gold in beach sand which refused to amalgamate even with the aid of potassium cyanide, but yielded instantly in presence of mercury cyanide in potassium cyanide solution. As these salts are rather expensive, it would be well to save the water and use it again in the battery if it could be cleared sufficiently from slimes. A little lime would be useful also if there should be any soluble iron or copper salt in the water.

IMPURE MERCURY.

It is generally understood that the presence of lead, copper, mercurous oxide, sulphur, etc., in the mercury is injurious to the amalgamation of gold. Sometimes the ore contains sulphate of lead, which, being to some extent reduced to the metallic state by the chemical action of the iron battery, will amalgamate with the quicksilver. In a similar manner, soluble salts of copper, either in the ore or in the water, cause a precipitation and amalgamation of copper, which, though less injurious than lead, and in one way beneficial by causing the iron surfaces to become coated with quicksilver, thus giving additional opportunity for catching the fine gold, is still injurious.[1] In all such cases the quicksilver strained from the amalgamation should be purified before being used again. It seems probable that the injurious effect of base metal in the quicksilver may be due rather to the formation of oxides than to the metal itself; at all events, the effect is bad, and those who have investigated the subject have come to the conclusion that pure mercury, or silver amalgam, is best, though there is some reason to think that zinc amalgam is sometimes useful, and cadmium amalgam shows remarkable readiness to attach gold to itself.

An instance is recorded of gold failing to amalgamate immediately in pans. The material treated was a coarse sand saved from the tailings in "riffle sluices", and containing gold to the value of $23 per ton, also a little iron oxide and a few sulphurets. After grinding in the pans 4 hours, the mullers were raised, quicksilver was added, and the working was continued 2 hours. No gold was found in the quicksilver, and the tailings assayed the same as at first. After trying repeatedly with the same result, the sand was ground to an impalpable pulp, allowed to dry during a couple of days, and then worked in the pan with raised muller. By this method from 85 to 90 per cent of the value was recovered. It is to be presumed the gold was in the fine particles of pyrite, which become oxidized by exposure when finely ground.

In order to remove small quantities of copper and lead from mercury retorting is not necessary. Such impurities may be removed by simply keeping the quicksilver for some hours in a wooden or any suitable vessel (for instance, an enameled pot) under dilute nitric acid, which is better warmed, and occasionally the metal should be stirred. The acid will dissolve the copper and lead until it becomes saturated. It may also dissolve some mercury, but that will be deposited again when a fresh lot containing copper or lead is treated with it, or the dissolved quicksilver may be recovered by immersing a piece of copper in the liquid. It is likely that the amalgam removed from the plates will contain a little copper, and it might be as well to keep the stock of quicksilver always under dilute nitric acid. When wanted for use it should be washed with clean water. The precipitation of lead or copper in the mortars may be prevented by adding a little soda or milk of lime to the water used, or by causing that to flow over broken limestone if the difficulty is in the water itself and not in the ore. Oxygen, sulphur, and chlorine may be removed from quicksilver by the addition of sodium amalgam, but an excess should be avoided. Lead is not usually wholly removed by retorting unless the quicksilver is covered to the depth of an inch or two with powdered charcoal. Leady quicksilver retorted once without charcoal will show a residue of lead when distilled a second time with charcoal.

BAD CONDITION OF PLATES.

Discoloration of the amalgamated copper plates, indicating oxidation of the copper, is one of the difficulties of the gold mill man. This is an interesting and important subject for investigation in regard to which many inquiries have been made. The electroplating of the copper surfaces does not seem to be efficient in preventing discoloration in all cases, and is not universally favored by mill men. Some consider the silver plating as very advantageous, while others say it is void of merit. One man observed that, although the silver soon wears off, yet when this occurs it leaves the plate in good condition for saving gold. A remarkable fact is that in the lower mill of the Sierra Buttes Company they discarded silvered plates, for the reason that the silver disappeared so soon that it would cost too much for the frequent replating necessary, while in the upper mill of the same company it is, to use the language of the superintendent, "impossible to work without silvered plates". The only observed difference between the two cases is that in the lower mill the rock worked contains a small portion of sulphurets, chiefly iron pyrites, while the upper mill works surface ore with no sulphurets. But in the Plumas-Eureka mill the ore contains pyrites as well as galena, and in the mills of the Washington district, in Nevada county, they have pyrrhotite and zinc blende, yet all these mills use silvered plates. In the latter mills it is found that with plain copper plates the quicksilver soon wears off. In this connection the following results have been obtained by experiment: pieces of sheet copper were coated with quicksilver and exposed to immersion in Spring Valley water. The plates which were amalgamated with the aid of nitric acid and mercuric chloride became tarnished in a few minutes and, on being cleaned with solution of potassium cyanide, washed in water, and again exposed, were again promptly tarnished, and so on indefinitely. Plates amalgamated by means of potassium cyanide, not using nitric acid, resisted tarnishing during the first hour, after which they behaved in the same manner as those on which nitric acid was used. Tarnishing was lessened by the addition to the water of slaked lime, and was prevented by a small quantity of ferrous sulphate, also by a trace of potassium bisulphate, not at all by caustic potash. Tarnishing was permanently prevented by placing an iron nail in contact with the amalgamated strip of sheet copper; also by contact with a piece of zinc. This makes a galvanic couple, and the oxidation is transferred to the more positive iron or zinc. Iron pyrites on the plate and in the water had no perceptible effect. One of the strips was then smeared with zinc amalgam and it remained bright for a number of hours, but after 24 hours was slightly tarnished. Another strip treated with a little mercury containing a little cadmium retained its color 3 days. In view of these and other known facts, it is recommended that mill men who have trouble with their plates should make some experiments, each separately, as follows: (1) place some bars of iron on the apron, say one across the upper end and one on each side edge, also one in the middle; (2) use zinc amalgam on the apron; (3) dissolve a little cadmium in the quicksilver for use on the apron and in the mortar; (4) fix a tank so as to deliver a small stream of water, containing potassium cyanide, into the mortar constantly while crushing. This has been done in some mills with good effect.

Those who have occasion to work auriferous material in pans would do well to try a solution of potassium cyanide in which a little red oxide of mercury is dissolved. The effect of this solution is to coat every particle of gold with quicksilver, which greatly aids the amalgamation. Not too much of the solution must be used, as it dissolves gold; however, it is believed that the dissolved gold can be recovered by using zinc amalgam in the pan toward the end of the operation. Before adding the solution the pulp should be made slightly alkaline by the addition of a little potash or soda. It is believed by many that zinc amalgam is very effective in catching gold, and still greater efficiency is claimed for cadmium amalgam. The pressure of zinc blende in the ore has probably a favorable effect on amalgamation by tending to prevent oxidation of the plates, with which it forms a galvanic couple in the same way as does a piece of zinc.

As to the loss of auriferous sulphurets, admitting that the best known concentrators are used with the requisite skill and care as to the adjustment of the machine, and the quantity of ore and water supplied to it, the manifest causes of the loss are similar to those of free gold, mentioned in the first two paragraphs. Flotation is promoted by the fineness of the particles of sulphurets and by the quantity and rapidity of the flow and turbidity of the water, to which may be added two other causes, namely, the tendency of cubical grains, as of some galena and pyrites, to roll down the inclined apron of the machines, and the property which some sulphurets have of not being wetted by water, in consequence of which, though specifically heavier than water, and remaining submerged when once beneath the surface, they will float if removed from beneath the water and again assailed by a wavelet. This phenomenon was observed particularly in Arizona, where an ore containing copper pyrites was treated on an Embrey concentrator, which is a traveling belt with an "end shake". The sulphurets would remain on the belt until the travel had carried them to a point beyond the jets, where the reflux of the water would leave them stranded, as it were, and when again overtaken by the wavelet produced by the "end shake", or longitudinal oscillation of the belt, would float. On viewing the belt from a suitable position, the surface of the water upon it was seen constantly covered by the floating particles. The attempt to concentrate the ore was a failure, the waste being too great. Perhaps a machine of a different class would have been more successful.

The loss of particles by rolling will probably be prevented by the new corrugated belts which are now being introduced with the Frue machines. Some loss of sulphurets may be occasioned by their not being entirely separated from the rock particles, in consequence of which there is not sufficient difference of density between the compound mass and the particles of pure gangue to enable a separation to be effected. The percentage of sulphurets which is lost is even more rarely known than that of the gold, and is more difficult to determine. The percentage of value saved from that going on to the concentrators is readily found by assays of the pulp supplied to the machines and of the tailings leaving them, corrected for the proportion of the weight which is retained as headings. Thus, suppose the material to be concentrated assays $2 per ton and the tailings assay 20 cents per ton, while 1 ton in 10 is retained as headings, we have in 10 tons of material $20, in 9 tons of tailings $1.80; consequently the 1 ton of headings must contain $18.20, and the recovery of value by concentration is 91 per cent.

The loss of quicksilver on the mother lode varies from 1 to 2 cents' worth per ton of ore usually, according to the richness of the ore. The monthly loss at the Keystone mill one year was 1,276 ounces troy, and 10 ounces additional in retorting; another, 861 ounces troy, and 10 ounces additional in retorting. At the Bunker Hill mine, 67.5 pounds avoirdupois are lost monthly, with about the same number of tons of rock crushed, say 100 tons per day, or 3,000 tons per month. Testing tailings in a horn does not show at these mills any quicksilver or flowered amalgam usually, but only apparently a trifling amount of sulphurets. The loss of mercury is caused largely by floating, and is usually less where the outside plates are cleaned up every day or two. In the few cases in which the loss is stated in gold mills it amounts to only a small fraction of an ounce to the ton of ore, and does not of itself constitute a serious item of expense; but the question suggests itself whether or not the lost mercury is charged with gold, which is therefore also lost. That some amalgam passes the aprons and plated sluices is proved in the North Star mill, Nevada county, where Gauthier's shaking amalgam table saves $50 per day between the sluices and concentrators. In this case the greater part of this amalgam would most likely have been saved by the concentrators had not the shaking apron intervened, and, though the mercury would have been lost in the subsequent treatment of the headings by roasting and chlorination, the gold would have been saved, minus the loss that would accrue during that treatment; but aside from the fact that it is not desirable to have amalgam mixed with the concentrates for treatment by chlorination, there are many cases in which concentrators are not used. In such cases the loss of $50 per day would not be insignificant in any mill. It is generally supposed by mill men that if they find but little amalgam or none on their lower plates they are saving all the gold, or at least the loss is infinitesimal. That this may be an erroneous supposition is shown by the fact that the Spanish mill amalgam is collected on the lower portion of the "tail plates" when none is found near the upper end, and a significant circumstance is that it is collected at a point where a curve is formed by reducing the pitch of the plates. The effect of the curve in the plates is worth attention. Mr. Tregidgo and others have found by direct experiment that a curved plate collects more gold than a flat one, and that a convexity is better than a concavity. That which collects gold will also be likely to collect amalgam and mercury. In the Plumas-Eureka mill 76 pounds of mercury are lost in working 4,600 tons of ore. The proportion of gold contained by dry amalgam varies with the degree of comminution of the gold from one-half to one-fifth. If we admit that the mercury is lost in the form of a dry amalgam, containing one-fifth of its weight of gold, the above quantity represents 95 pounds of amalgam, containing 19 pounds of gold, which, with 14.58 troy ounces to the pound, at $14 per ounce, would give a value of $3,878.28 to 4,600 tons of ore, or 84.31 cents per ton. However, it may be conceded that not all of the lost mercury is in the form of dry amalgam.

As to the causes of the loss of mercury, it may well be supposed that a portion of that loss is due to ordinary wear; that is, that the metal is, to a slight extent, subject to attrition by sand and water, the result being a quicksilver dust of such extreme fineness as to be incapable of being recovered. Another portion is lost by handling, by adherence to the fingers of workmen, by splashing when poured, etc., and it is quite possible that a little may become oxidized or combined with sulphur or other mineral matter from the ore. Some undoubtedly evaporates at ordinary temperatures, though in scarcely appreciable quantities. In the process of retorting the amalgam there may be a failure to expel quite all of the quicksilver, a portion remaining with the gold, and not all that is expelled is condensed and collected, as at the Keystone mill, where 10 ounces monthly are thus lost. Another way in which some quicksilver may be lost in gold mills, as it certainly is in silver mills, is by adherence to metallic particles which are attached to the gangue. In this case it is the gold that steals the quicksilver, instead of the reverse. The discovery of the cause and the prevention of undue oxidation of the plates will obviate one important source of loss of amalgam. Frequent removal of the amalgam from the mortars seems to be beneficial, and the common practice of running for a month, or until the shoes and dies are worn out, before cleaning up appears to be bad. Therefore, on account of the waste of amalgam by abrasion or extreme comminution, it might be found profitable to clean the batteries, at least partially, every two or three days, notwithstanding the loss of a little time in so doing.

As a substitute for silver plating, some mill men smear the amalgamated plate with silver amalgam. There is some diversity of opinion and practice in the matter of preparing the copper plates when not silvered, and some operators think they have processes of unequaled efficacy. It makes no difference as to how the mercury is induced to attach itself to the plate, unless it may be in the expense, provided the amalgamation is thorough, and that any chemicals used in the process are afterward completely removed by washing. An efficient way in which to amalgamate a plate is first to clean the surface thoroughly by pouring on it nitric acid of such strength as to "bite" promptly and effectively, then wash repeatedly with clean water; next pour on a solution of corrosive sublimate, which will cover the entire surface with a slight film of mercury, again wash, and then, on pouring quicksilver upon the plate, it will spread over the entire surface with the greatest facility; even a film of oil on the plate can not prevent the spreading or adhering. A method preferred by some, though more laborious, is to scour the plate with sand until it presents a bright, clean surface, afterward rubbing it with quicksilver and solution of cyanide of potassium. Others prime the plate by means of a solution of mercury in nitric acid, following that with metallic mercury.

It does not require any great skill to amalgamate copper plates, but to keep them always bright and active while in use is more difficult. What seems, however, to be a good plan is to anneal a new plate before amalgamating it. This softens the hard film produced by the rolling mill and leaves the plate in a better condition for catching the gold on its surface.

There is in most gold mills a want of intelligent adaptation of means to the end sought in amalgamation. The finer particles of gold are those which are the more liable to be carried away in suspension, and which consequently require the greatest feasible exposure to the possibility of contact with the amalgamated surface of the plate. The coarse gold is amalgamated in the battery. The coarser of those particles which are thrown out of the mortar by violent agitation of the water within are readily arrested on the apron. What, then, is the object of the plated sluices through which the pulp is afterwards conducted? Manifestly it is to save those finer particles which continue to move with the current. Is it, then, philosophical to increase the violence of that current by restricting it to a narrower channel, which is done in almost every instance, the aprons having a width of from 4 to 5 feet, while the plated sluices are only from 14 to 16 inches wide? If the sluice was turned sidewise to the stream, the plates curved as a segment of a cylinder, and the pulp spread over a width of 12 feet instead of 16 inches, and at the same time suitably diluted with clean water, it would probably deposit more of the suspended gold in the 16 inches of traverse across the plate than it now does while rushing through the 12 feet of length with only 16 inches of breadth. The principle has been demonstrated to be correct by actual experiment.

There is a manifest tendency toward an increased use of wire-gauze screens in wet crushing mills in some parts of the state. It has often been asserted, and is perhaps generally believed, that brass-wire screens can not be used with quicksilver in the battery, and for this reason screens of that character have been left generally to the silver mills, while even they have more commonly used punched screens for wet work. The general idea is that the brass will become amalgamated, and that first choking and then destruction of the screen will ensue; but this does not seem to be the case, which will not greatly surprise any one who has tried to amalgamate brass without using some kind of chemical to induce adherence of the mercury. With some ores, especially those which contain zinc blende, the brass screens have been known to become amalgamated in 12 hours without the use of chemicals in the battery.

Screens made of common tin plate, punched in the usual manner, are being used to the astonishment of many who had supposed that the mercury would lay hold of the tinned surface and cause choking of the screen, whereas, in fact, the special merit claimed for the tin screens by those who use them is freedom from choking, which may be due to the thinness of the plates. Tin screens are used in Amador county by one or two mills. The tin is burned off previous to using. They do not last long, but the old screens, having some little gold attached, are returned for new ones, pound for pound, and they are found to discharge well. In many, if not in all, of the best gold-quartz mills the screens are not more than 8 inches high, often not more than 6 inches, and experience proves that this is ample, and that the old style of from 14 to 16 inches high has no advantage over the present. As to placing the screens vertically, or with a slight inclination outward, it seems to make no appreciable difference.

In batteries the tendency is toward heavy stamps, some of the new mills having them of 1,100 pounds weight, while 1,000-pound stamps in some sections are becoming quite common. Another change is the increasing substitution of riffles for inside plates. The riffles are cast on an iron back plate, which is fixed in the mortars, and are said to catch a great portion of the amalgam. Steel shoes and dies are usually considered more economical than iron, and are being more generally used than formerly. In some California mills, as well as in the Silver King mill, in Arizona, it has been found that the steel dies become worn in holes, and so irregularly as to be rendered useless long before they are worn down to the requisite size for abandonment, while the shoes remained in excellent form. In these cast-iron dies were used with steel shoes very advantageously. The inference to be drawn from this irregularity of the wearing of the dies is that the material of which they were made was of a bad quality. It is commonly stated at the mills where steel is used that the shoes and dies of eastern make are much superior to those made in California, and at the Plumas-Eureka mill the English article is declared to be better than either of the others.

Tappets and cams of steel are now becoming common, and give great satisfaction. The tappets are generally counterbored, and this practice is also being applied, though less generally as yet, to cams. The effect of the counterbore is to give the cam or tappet three points of contact with the shaft instead of only two, as when the core is circular, the counterbore being slightly oval, with the longer axis passing through the key seat in the cam or the gib in the tappet. This gives greater stability by preventing oscillation or wabbling.

In regard to the weight of the stamp, it must be remarked that the nominal weight, as given at the foundries, is greater than the actual weight. The former is the gross weight, the latter the net weight, of the finished stamp, including stem, boss, and shoe. The difference may be 50 pounds, by which amount the reported weight must be reduced in general. Unfortunately the most advantageous weight of stamps for crushing gold quartz can not be deduced from a comparison of the stamp duties in the different mills, because the stamp duty is a function of many different quantities. The hardness of quartz, as tested by scratching, is nearly uniform; but the facility with which it may be crushed depends greatly on its texture, as whether it is friable, like that of the Yuba mine, or compact. The size of the lumps of ore falling under the stamps exercises an important influence on the stamp duty, for, while a large piece manifestly requires more force to crush it than a small piece, it unfortunately happens in a battery that the larger the piece the less force is applied, because the drop of the stamp is proportionately reduced at the time when it should be increased. For the same reason the manner of feeding makes a great difference, high feed taking more from the fall of the stamps than low feed.

Naturally, the more the rock is broken into small pieces before it goes to the battery the lower and more uniform can the feed be made and the less drop will the stamps require; hence the frequency of the drops can be increased, and more ore can be crushed with the expenditure of a given amount of power in lifting the stamps. At the Silver King mill, in Arizona, the stamp duty with a given drop was increased fully 20 per cent by the use of a good rock breaker, as compared with the results of breaking by means of hand hammers. Then not only the grade of screen used, but the height of the discharge above the dies, the width of the mortar, the extent and rate of stamp drop, the quantity of water used in the battery, the proportion of the sulphurets, all influence the rate of crushing, even though the ore may be essentially quartz, and when different kinds of rock also enter into the question it becomes so much the more involved.

In the Delhi mill stamps of different weight are used, namely, 1,000 pounds and 1,100 pounds, the screens and drops being equal. This would afford a good basis for comparison but for certain circumstances. In the first place, the diameters of the shoes are not proportioned in the ratio of the weights, being, respectively, 9 and 10 inches, giving the crushing surface ratios as 81 to 100, while the weight ratios are as 90 to 100. In the second place, the heavier stamps are 5 in battery, while the lighter are but 4, which places the latter at a disadvantage in two ways: first, because the order of the drops can not be so well arranged, in consequence of which 2 adjacent stamps follow each other, which is a disadvantage; second, because one-half of the 4 stamps are necessarily end stamps, while in the other case only two-fifths are end stamps, and it is conceded that the end stamps do less crushing than the others in a mortar. Thus the statement of the mill foreman that the 5-stamp batteries crush one-half ton per stamp a day more than the 4-stamp batteries, while doubtless true, can not be accepted as proof of the superiority of the heavier stamps, which consume less power in proportion to the work done; that is, they require one-tenth more power and do one-fifth more work, nearly.

The Blue Bell and Washington mills, in Nevada county, are alike in weight of stamps, drop, number of drops, and grade of screens, yet the respective stamp duties are 1.7 and 2.2 tons, while the Yuba, with 50 pounds more weight of stamp, 1.25 inch more drop, and 4 less to the minute, has a duty of 2 tons. The power required for the Blue Bell and Washington is to that required by the Yuba as 4,399 to 5,418, while the mean duty of the first two is to the mean duty of the last as 195 through 30 meshes to the inch to 200 through 40 meshes. The additional power consumed in the Yuba, equal to nearly 23 per cent, gives nearly 2.7 per cent more ore crushed through a sieve which has nearly 78 per cent more meshes to the square inch. The value of the difference it is impossible to compute in terms of power required, hence this comparison is of little utility.

The Gaston Ridge mill, with 750-pound stamps, consuming a power represented by 58, has a duty of 2.75 tons daily, while the Omaha, with 900-pound stamps and a power consumption represented by 50, gives a duty of 1.6 tons daily, the screens being of the same grade in both. In this case the lighter stamp consumes the greater amount of power, owing to the higher and more frequent drop, and it crushes nearly 72 per cent more ore with 16 per cent more power, which is largely in favor of the lighter stamps. Again, the Mayflower, with 950-pound stamps and a power in the proportion of 59, crushes 2.5 tons through the same screen; hence, with slightly less power, the lighter stamp again crushes more than the heavier by 10 per cent.

Comparing the mean results of the Blue Bell and Washington with the results of the Crown Point, we have:

Weight of stamps	850 pounds; power, 44; duty, 1.95
Weight of stamps	750 pounds; power, 45; duty, 1.50

As the screen is the same, the result is in favor of the heavier stamp.

The following are the results of some calculations of the proportionate power required to crush 1 ton of ore in different mills. The proportional power is found in this way: The nominal weight of the stamp is corrected by the subtraction of 50 pounds for trimming and mean wear. The stated drop is reduced by 1 inch to allow for the loss of drop by the ore under it. The corrected quantities are then multiplied together, and the product is multiplied by the number of drops per minute. This product divided by the stated stamp duty gives a relative figure representing the power used in lifting the stamps.

PROPORTIONAL POWER REQUIRED TO CRUSH ONE TON OF ORE AT VARIOUS CALIFORNIA MILLS.

SCREEN, NO. 9 SLOT.		SCREEN, NO. 7 SLOT.		SCREEN, NO. 6 SLOT.		SCREEN, NO. 5 SLOT.	
Nominal weight of stamp. (Pounds.)	Proportional power to 1 ton.	Nominal weight of stamp. (Pounds.)	Proportional power to 1 ton.	Nominal weight of stamp. (Pounds.)	Proportional power to 1 ton.	Nominal weight of stamp. (Pounds.)	Proportional power to 1 ton.
950	144	850	207	850	144	850	168
900	109	750	168	850	174	750	151
800	198	750	151	750	166	....	....
800	144	....	....	....	....	....	....
650	255	....	....	....	....	....	....

These results show the impossibility of deducing anything useful in this respect from the records of different mills working on different ores.

Of machines other than stamp batteries for the reduction of auriferous rocks the writer can say but little, unless as to the work at the Spanish mine, in Nevada county, where perhaps the lowest grade of milling rock that has ever been made profitable in this country is successfully worked in Huntington centrifugal rolling mills.

By reference to the notes on the mine in question in the report of the state mineralogist of California in 1888 it will be seen that the ore yields an average of 70 cents per ton, on which a profit of 20 cents per ton is realized. It goes without saying that the conditions are exceptionally favorable for extracting and milling the ore at little cost, and that a cheap class of labor is mainly employed; yet one must admire the courage of the man who not only undertakes to handle 70-cent ore without loss, but has actually paid off some $8,000 of debts from the proceeds. In this plant the 5-foot Huntington mills work daily some 35 tons each of soft slate mixed with a little ferruginous quartz. It must not be hastily inferred that this mill is suitable in all cases.

The Tustin mills have worked satisfactorily in Calaveras county, at the Willard mine, where they have been used for crushing ore for amalgamation on plates and concentration of the sulphurets. Mr. T. B. Morse, E. M., in his report on this mine, published in the report of the state mineralogist of California for 1886, speaks of the work of this machine, in comparison with stamps, as follows:

A comparison of the two methods of crushing shows a marked difference in the results. In crushing through the battery a large amount of slimes is produced; with the pulverizer a very small quantity of slimes is made. As a consequence, with ore where the rock is very hard, the gold exceedingly fine, and the sulphurets soft and brittle, it is found that on the same ore a much greater percentage of the fine gold is amalgamated after the pulvervizers than after the stamps, and in concentrating only 18 to 20 per cent of the assay value of the ore can be saved after stamps and 85 per cent after the pulverizers. On the same ore and with the same screen 1 pulverizer is about the equivalent of 6 to 8 stamps, according to the character of the ore.

This verifies what has been said as to some of the causes of loss of gold and of sulphurets.

Another machine is Kendall's national rocker. A mill of this kind is worked at Bald Hill, in Placer county, and Mr. Bell, the owner, states it is giving excellent results from hard quartz containing free gold and pyrites. It was also tried at the Spanish mine, and although not so satisfactory as the Huntington, it did as well as a stamp battery. The Wiswell and Bryant mills, which are modifications of the well-known Chili mill, or edge wheel, are well spoken of in some quarters. All these mills are essentially rolls, differing from the Cornish and Krom rolls chiefly in that they consist of a roller or rollers working against a plane, or a ring-formed base, instead of against another roller, with the advantage that the ore does not escape until it is fine enough, while, especially in the Tustin pulverizer, it is not subjected to much needless trituration. It is well known that they produce less slime than batteries do, and crush the ore with more evenness. While stamps may be best in many cases, it may well be that some of our mill men go too far in giving them the preference in all.

It has been shown that one cause of a loss of gold may be excessive trituration in the battery. One of the radical defects of the battery is that the rock is not completely expelled from the mortar as it becomes fine enough to pass the screen. It would be easy to demonstrate that it can not be, but that is unnecessary, as the point is universally conceded. On the other hand, a loss, more or less, is always sustained for the want of trituration of a portion of the ore, leaving many particles of gold still inclosed in the stone. The notes in the report show a very general preference for the Frue concentrator; nevertheless, where the Frue and Triumph are used side by side in the same mill there seems to be no difference in the results obtained, though preference is still given to the Frue, for the reason, as stated by the mill men, that it requires less care and attention than the other, which is to say equally good results are obtained with less trouble. How far the preference may be due to the fact that the Frue was first in the field the future must determine.

As a motor, where water power under high fall is available, the practical verdict of the mill men is in favor of the Pelton wheel.

In Amador county, California, more Knight wheels are used than Pelton, and as many Donnelly as Pelton. Knights are generally used in hoisting works, on account of the hydraulic nozzle. With 2 6-foot Knight wheels and power gates and nozzles the engineer can run the cable 400 feet per minute and stop the skip within a foot from the place it occupied when the gate was closed. These nozzles do not work in a bucket shaped like the Pelton. The Pelton wheels under most heads work to a higher percentage. The Donnelly wheel is used with any number of round nozzles. The buckets are fastened on the wheel, as in the case of the Pelton. Overshot wheels are rather frequently used with low falls, but are open to the objection of a great tendency to become loaded with ice in cold weather; moreover, a Pelton will work with a low fall, and is cheaper than an overshot of large diameter. The true turbine wheels are not much used in quartz mills, probably because a turbine for high fall is of very small diameter, and consequently must make so many revolutions per minute that excessive "gearing down" is necessary in order to obtain the very moderate rate of revolution required in most parts of a rock mill, which is not the case with a Pelton, a Knight, or a Donnelly, as these can be made of much larger diameter for any given fall, and hence make fewer revolutions per minute. Another difficulty with at least one of the best turbines is that, if not worked at full gate, any suspended matter in the water, even mica, lodges in the wheel case and obstructs the movement of the gates when that becomes necessary; also, the efficiency of such wheels is much impaired by a small amount of wear.

The feeders in use, where not some simple home-made contrivance, as the "box feeder", or the more ingenious "bucket-roller" feeder in the Ready Relief mill, are almost universally the Hendy Challenge. The Templeton or roller feeder is used exclusively in the Keystone mill, and is giving entire satisfaction, and the same feeder in the Bunker Hill mill works side by side with the Challenge, and though the latter is considered the better machine, it is much more costly.

The writer has examined a sample of concentrated sulphurets as to an alleged volatilization of gold in roasting them in the muffle without salt. The sender stated that he found a loss of $22 in gold and 2 ounces of silver to the ton. Two assays were made on the raw material with very nearly concordant results, and two others were carefully roasted prior to the smelting, the results of these also nearly agreeing. The difference between the means of the raw and the roasted assays showed a loss of 0.3 ounce of silver per ton, or about 1.5 per cent of the total silver. There was no loss of gold. The ore contains, besides iron pyrites, tellurium and antimony; not any copper. In the experiment the ore was roasted with very low heat, and under a perforated cover to prevent loss by decrepitation, for about 45 minutes, being twice removed from the muffle, cooled, uncovered, and stirred. Afterward the covers were removed and the roasting was continued for half an hour longer under higher heat; the ore then smelled quite "sweet", and was assayed in the usual manner. The roasting dishes were well coated on the inside with reddle, and after the roasting the bottoms were scoured with ground glass to remove any metal which might have passed into or adhered to the substance of the dishes, the resulting dust being added to the assays. The losses noted by the sender must be ascribed to the decrepitation of the ore, too rapid roasting, or absorption into the dishes, or to all of these causes combined, neither of which, however, would have much effect in the roasting in a 3-hearth reverberatory furnace.

CHLORINATION OF GOLD ORES.

The following in relation to the practical chlorination of gold ores by the barrel process and the precipitation of gold from solution was contributed by Mr. John E. Rothwell to the Engineering and Mining Journal, New York, February 7, 1891:

This is a record of actual, successful working experience on a large scale in 1890.

The chief objection to a plant of 50 tons or more capacity in 24 hours for the Plattner process is its enormous size and the length of time it requires to complete a single operation. Therefore, the problem the engineer has to solve in attempting to treat low-grade ores that will not concentrate is to find a process that will treat his ores in large quantities quickly, cheaply, and with as little interruption as possible. It may therefore be of interest to hear of one solution of this problem that has been demonstrated beyond a doubt. In the reduction works, of which this article treats in particular, the ore is crushed dry in Blake and Gates crushers and 2 sets of Krom rolls, roasted in Brückner furnaces of 3 tons capacity, and chlorinated in barrels of 3 and 4 tons capacity.

CRUSHING.

The first thing to be considered in treating an ore is to crush it properly. To do this a series of experiments has to be made to ascertain how coarse the ore may be to give the best result in the after treatment, with reference to economy, large capacity, and best extraction. The pulp for the best leaching must be in granular condition, and carry as small a percentage of dust or slimes as possible. For this purpose rolls properly managed are especially well adapted. A few lessons from experience with rolls may not be out of place here. The chief point is to have enough of them to make the reduction in size of particles passed through them gradual. 2 sets are sufficient, but 3 will do better. The ore should come to the coarse rolls not coarser than three-fourths inch mesh, and these rolls should be set about three-eighths inch apart. The middle rolls are set about three-sixteenths inch or less apart, and the fine rolls about as far apart as the size to which the ore has to be crushed. If only 2 sets are used, the coarse are set a little closer than with 3, and the fine remain the same. The springs should be set up so tight that they will not give to the hardest pieces of ore, but will allow a piece of steel or iron to pass through without throwing the belts. The periphery speed of the rolls should be about the same as or a little faster than the falling speed of the ore, and the ore should be fed in an even sheet across the surface of the roll. Little trouble will then be experienced in keeping the surfaces true and in producing a granular pulp carrying but a small percentage of dust. If rolls were made of larger diameter and narrower, the result would be a still more gradual reduction, and possibly a greater capacity. The writer has used those of 39.5 inches (1 meter) diameter and 12 and 15 inches face.

ROASTING.

The roasting of the ore is one of the most important operations in its influence on the success of chlorination, but as the characteristics of each ore must be studied, none but general rules can be laid down as to how roasting should be done. It is absolutely necessary that the ore be roasted as nearly dead sweet as possible.

CHLORINATION.

The chlorination barrel in the works of which the writer has charge is made also the washing and leaching vessel. This is done by placing a supporting diaphragm, for a filtering medium, to form the chord of an arc of the circle of the barrel. The diaphragm, or "filter", as it is called, is made up of plates, corrugated similar to the ordinary filter-press plate, and perforated with holes every 4 or 6 inches square. These plates are supported on segments, which are bolted to the shell. On top of the corrugated plates is placed the filtering medium, an open-woven asbestos cloth. It is about as coarse as the ordinary gunnysack, but the warp and woof are of much heavier thread. Over this is placed an open grating, and the whole is held in place by cross pieces, the ends of which rest under straps bolted to the inside shell. In this way, while the whole is rigidly held in place, it is very easily and quickly removed when the changing of the asbestos cloth becomes necessary. 2 valves on each end of the barrel, above and below the filter, are for the inlet and outlet of the wash water and solution, respectively. The barrel is charged by first filling the space under the filter with water, which at the same time is allowed to pass through the filtering medium and wash it; then the required quantity of water is put in above the filter. There are now two methods of charging the pulp and the chemicals, lime chloride and sulphuric acid. In one the lime is so placed in the ore charge in the hopper over the barrel that it goes in with the ore and is completely buried with it. The acid can then be added with very little danger of generating any gas before the plate on the charging hole can be put on and securely fastened. The other way, which seems to be still better, is to pour the acid first into the water, through which it sinks in a mass to the bottom and does not mix. The ore is then let in, and the lime added the last. The chances of generating any gas are much less than in the first method. A barrel charged in this way has been known to remain open for from 5 to 10 minutes after charging without generating gas, but it has been demonstrated that on the first revolution of the barrel the gas is immediately liberated, and creates considerable pressure. After the chlorination is complete the barrel is stopped, so that the filter assumes a horizontal position. The hose is attached to one of the outlet pipes and conducts the solution to the reservoir tank. A hose is also attached to the inlet pipe, and water is pumped in under pressure, and the leaching commences. The air in the top part of the barrel is compressed and forms an elastic cushion, which gives the wash water perfect freedom to circulate evenly over the whole surface of the charge and wash every portion of it thoroughly and with the smallest quantity of water possible. By washing in this manner no gas is allowed to escape into the building. The solution runs into a covered reservoir tank, from which an exhaust fan draws the excess of gas and discharges it outside the building. The length of time required to do the leaching varies with the leaching quality of the ore treated, charges having been leached in 40 minutes with a pressure of from 30 to 40 pounds per square inch. With higher pressures the time can be materially shortened. As can readily be seen, the ore in the barrel is in the best possible shape for rapid and perfect leaching. When the barrel is stopped the ore settles on the filter, the coarsest and heaviest on the bottom and graduated evenly over the whole surface and up through the charge to the slimes on top. In order to facilitate the leaching of charges carrying an excess of dust or slimes, a valve placed in the casting of the head, on a level with the surface of the pulp, is opened just after the barrel is stopped, and the dust and slime which remains in suspension is run off into an outside washing filter press, where it can be treated separately, and the charge washed in the usual way. The tailings are discharged into a car which will hold the whole charge of ore and water, and then run out; or, if water is abundant, they are discharged into a sluice and washed away.

For leaching purposes the amount of water necessary to wash a charge varies very little with the richness of the ore, which goes to show the perfect leaching condition of the ore in the barrel. The amount required is about 120 gallons per ton more than the quantity used in the barrel for chlorination, which is about 100 gallons per ton.

In order to get a concentrated solution for after treatment and to reduce the amount of solution to be treated, also saving in water, a tank is placed above the barrel, and when the richest of the solution and wash water has run out into the reservoir tank the discharge hose is connected with the pipe leading to the upper tank, and the washing is finished into it. The solution collected in this way is used in the next following charge in the barrel. The quantity of solution to be precipitated is thus reduced to about 120 gallons per ton of ore treated.

The advantages of this method of treating ores are many, among which may be cited the small amount of labor, and especially of skilled labor, necessary; the freedom of the building from chlorine gas; the control one has over the perfect washing of the charge; the small amount and simplicity of the machinery for the great amount of work accomplished. One man of ordinary intelligence and a helper are able to take care of 3 barrels; that is, look after the charging, leaching, and discharging. If the tailings are sluiced out, they can also attend to it; but where they have to be trammed out one more man is necessary. The disadvantages are due to the construction necessary, but do not interfere in any way with the successful working of the barrel. They are principally the amount of space taken up by the filter and the portion of the barrel under the filter, and the fact that when the barrel is charged and running it is not in a perfectly balanced condition. These disadvantages can be overcome to a great extent by a little different construction. By using a filter placed close to the shell, only space enough being left between it and the shell to allow of free circulation, and reaching to the same height on the sides as the horizontal filter, then by using compressed air to displace the solution and wash water, an equally good result could be had.

PRECIPITATION.

For the collection of the solution 2 tanks are necessary, each of ample capacity to hold a day's solution from all the barrels. Those for collection are placed on the same floor as the chlorinators, or, where there is sufficient fall, on the floor below. Then on the floor below them are the precipitation tanks, which should be of the same capacity as the collecting tanks and the same in number. The limit to the size would probably be a 50-ton capacity. Where more is treated another battery of tanks would be necessary. For a precipitant the writer has found hydrogen-sulphide gas, generated from paraffin and sulphur or iron sulphide and sulphuric acid, to give the cheapest and most satisfactory results. It is generated and then forced through the solution with a small air pump, which at the same time forces air through and keeps the tank of solution in an agitated state and expels the free chlorine gas. In this way a precipitation can be made in a short time, and the precipitate is in a collected and flocculent form that settles quickly. To save time the gas is turned into the tank while this is filling up, so that when the tank is full a very few minutes finish the precipitation and collection. The tank is now allowed to stand for 2 or 3 hours, when it has settled sufficiently to draw the supernatant liquor off through a filter press. There is little danger of precipitating arsenic or antimony that may be in the solution when it is worked cold, as they do not commence to come down till some time after the gold has precipitated and collected. Of course any copper or lead in solution will be precipitated with the gold, which would not make this precipitant desirable where there is considerable of either metal in solution; but with small quantities they are easily taken care of in the after treatment. The loss in gold is considerably less if the precipitate is allowed to accumulate in the tanks and a clean up made after 6 or 10 precipitations than if it were filtered through a press and collected after every precipitation. There does not seem to be any advantage derived from a continuous precipitation and collection on this account if hydrogen-sulphide gas is used as the precipitant, as the filters will soon become so coated and clogged with the sulphides as to retard rapid filtration without extreme pressure, which is sure to increase the loss. The handling of a large number of filter cloths is also a source of loss, no matter how carefully it may be done. The same objection applies to all continuous precipitation schemes where large quantities of solution are handled.

The asbestos filter cloth can be changed in about an hour and a half, and under ordinary conditions will last for upward of 100 charges. One cloth has been known to last 150 charges, so that this objection to the filter inside the working barrel is really nil.

The life of the supporting plates and grating can be made to equal the life of the lining of the barrel, and that with barrels that have several thousand charges to their credit shows little signs of wear yet.

CHEAP MINING AND MILLING IN 1888 AND 1889.

The following description of the work at the most economical gold mines and mills in the United States is put on record as showing the minimum costs attained at the date of the Eleventh Census, 1889:

The cost of working at the Spanish gold mine, California, has proved to be the lowest on record. While the mine is not operated on a large scale, it has the advantage of water power and of having soft ore at and near the surface and easily run into the mill. Taking the cost per ton for mining and milling together, this report makes the best record, and is in its way as remarkable as the famous run of the North Bloomfield hydraulic mine. The lowest mine cost per ton was 31.4 cents, and milling cost 20.8 cents, or 52.2 cents per ton total, in November, 1887. The highest total mine and mill cost per ton between September, 1887, and March, 1888, was 60.6 cents, and the monthly returns were pretty regular. Even at these rates the margin for profit is not large.

The following information was furnished to the Engineering and Mining Journal, May 5, 1888, by Mr. F. W. Bradley, the lessee of the mine:

Ore can be handled here cheaply because the mining is in a large deposit of soft slate that crops out from 30 to 100 feet in width on the face of a steep mountain. This slate is seamed in every direction by small stringers of quartz. There is a little gold in the slate, some in the quartz, and considerable in a loose free state in the clay parting between the quartz and the slate. The formation has a pitch of about 80 degrees from the horizontal. When the weather permits, the mining is done in open cuts on the croppings over the main working tunnel, which starts from the surface immediately at the top of the mill building and follows the course of the deposit into the mountain. During stormy weather ore is obtained from accumulated supplies and by stoping the best portions of the deposit over the tunnel and replacing the same by square sets of timber in such a manner as to form ore bins for storing and loading into the tunnel cars ore broken in the cuts. In the cuts the softest streak near the foot wall is stoped by Chinese miners. Ore left on the foot wall soon slacks off and ore on the hanging wall and also portions of the hanging wall cave in. All waste is separated as much as possible from the ore and left in the worked-out cuts, there being a strong pillar left at the end of each cut. The tunnel has a grade of 2.5 inches to 16 feet. A brake on the last car controls a train of 10 loaded cars coming out, and a mule easily hauls back the empty train.

MILLING PLANT AT THE SPANISH MINE.

4 Huntington mills and self-feeders	$6,340.22
Labor, setting up and building	2,304.83
Silver-plated amalgamating plates	1,985.35
Water pipe and wheel, shafting, and pulleys	1,220.75
Lumber, building, and V flume	1,194.52
Hardware	1,026.08
Blake crusher	618.45
Cost of milling plant under cover and running	14,696.20

Freight, $24 per ton from San Francisco; lumber, $22.50 per thousand.

The mills crush from 120 to 140 tons per day, depending upon the proportion of quartz in the ore. Amalgamation is done inside the mills, obtaining 45 per cent of the gold saved around and inside the mills and 55 per cent on the plates. The tailings are not touched after leaving the plates. One ounce of quicksilver is lost for 16 to 31 tons of ore crushed, depending upon its value.

In experimenting with screens, a No. 6 slot was used for a long time, but was finally replaced by a No. 5.

The Huntington mill is peculiarly adapted for working this ore, and with stamps the mine would not pay.

In the first 10 months 1 5-foot mill and 1 4-foot mill crushed 17,200 tons of ore. 2 5-foot mills were then added to the plant. Since then the 4 mills have crushed 19,402 tons. The ore, of which 27 cubic feet is called a ton, consists of about one-third hard quartz, one-third tough slate, and one-third decomposed quartz and slate. The 4 mills require 22 horse power, are run at 60 revolutions per minute, and discharge through a No. 6 slot screen. During the last 4 months the mills have averaged 136 tons of ore per day.

RESULTS AT THE SPANISH MINE, NEVADA COUNTY, CALIFORNIA, IN 1888 AND 1889.

ITEMS.	SEPTEMBER. 22 days, 2,796 tons of ore.				OCTOBER. 28 days, 3,443 tons of ore.			
	Total.	Labor.	Supplies.	Per ton.	Total.	Labor.	Supplies.	Per ton.
MINE.								
Mining	$572.32	$486.59	$85.73	$0.21	$816.91	$703.50	$113.41	$0.24
Dead work	280.30	237.30	43.00	0.10	116.13	105.20	10.93	0.04
Delivering ore to mill	136.70	126.00	10.70	0.05	178.15	160.20	17.95	0.05
General expenses	61.82	58.22	3.60	0.02	80.30	78.35	1.95	0.02
Total	1,051.14	908.11	143.03	0.38	1,191.49	1,047.25	144.24	0.35
Cost per ton	0.38	0.33	0.05	....	0.35	0.31	0.04	....
MILL.	20 days, 2,796 tons of ore.				24.5 days, 3,443 tons of ore.			
Mill expenses	306.55	163.45	143.10	0.11	421.65	227.32	194.33	0.12
Water for power	152.20	....	152.20	0.05	161.70	....	161.70	0.05
Handling ore	124.46	121.50	2.96	0.05	159.85	154.50	5.35	0.05
General expenses	61.53	58.23	3.30	0.02	80.35	78.40	1.95	0.02
Total	644.74	343.18	301.56	0 23	823.55	460.22	363.33	0.24
Cost per ton	0.23	0.12	0.11	....	0.24	0.13	0.11	....
Bullion produced	3,268.49	....	....	1.17	3,138.55	....	....	0.91
Total expenses	1,695.88	....	....	0.61	2,015.04	....	....	0.50
Profit	1,572.61	....	....	0.56	1,123.51	....	....	0.32

RESULTS AT THE SPANISH MINE, NEVADA COUNTY, CALIFORNIA, IN 1888 AND 1889—Continued.

ITEMS.	NOVEMBER.				DECEMBER.				JANUARY AND FEBRUARY.			
	30 days, 4,047 tons of ore.				25 days, 2,972 tons of ore.				36 days, 4,256 tons of ore.			
	Total.	Labor.	Supplies.	Per ton.	Total.	Labor.	Supplies.	Per ton.	Total.	Labor.	Supplies.	Per ton.
MINE.												
Mining	$876.28	$679.63	$196.65	$0.21	$559.84	$458.64	$101.20	$0.19	$515.37	$374.18	$141.19	$0.12
Dead work	115.25	100.90	14.35	0.03	250.51	230.22	20.29	0.08	481.53	434.23	47.30	0.12
Delivering ore to mill	206.94	193.25	13.69	0.05	211.19	189.75	21.44	0.07	262.85	239.85	23.00	0.06
General expenses	75.45	70.70	4.75	0.02	72.50	69.26	3.24	0.03	127.94	121.26	6.68	0.03
Total	1,273.92	1,044.48	229.44	0.31	1,094.04	947.87	146.17	0.37	1,387.69	1,169.52	218.17	0.33
Cost per ton	0.31	0.26	0.05	....	0.37	0.32	0.05	....	0.33	0.28	0.05	....
MILL.	29 days, 4,047 tons of ore.				23 days, 2,972 tons of ore.				32 days, 4,256 tons of ore.			
Mill expenses	388.49	225.67	162.82	0.10	336.02	175.26	160.76	0.11	481.76	239.49	242.27	0.11
Water for power	203.00	5.00	198.00	0.05	143.00	5.00	138.00	0.05	206.00	5.00	201.00	0.05
Handling ore	179.40	177.00	2.40	0.04	155.49	152.25	3.24	0.05	205.62	204.00	1.62	0.05
General expenses	75.46	70.71	4.75	0.02	72.50	69.26	3.24	0.03	127.92	121.25	6.67	0.03
Total	846.35	478.38	367.97	0.21	707.01	401.77	305.24	0.24	1,021.30	569.74	451.56	0.24
Cost per ton	0.21	0.12	0.09	....	0.24	0.14	0.10	....	0.24	0.13	0.11	....
Bullion produced	2,644.57	....	....	0.65	1,950.85	....	....	0.66	2,783.49	....	....	0.65
Total expenses	2,120.27	....	....	0.52	1,801.05	....	....	0.61	2,408.99	....	....	0.57
Profit	524.30	....	....	0.13	149.80	....	....	0.05	374.50	....	....	0.08

LOW COST OF MINING AND MILLING AT THE DALMATIA MINE, ELDORADO COUNTY, CALIFORNIA, IN 1890.

[From the Engineering and Mining Journal, December 6, 1890.]

The Dalmatia mine is owned by an English company and is managed by Mr. George Cullen Pearson. The mine is located on the summit of a broad ridge between Rock creek and the South Fork of the American river, three-quarters of a mile east of Kelsey. It contains a wide belt of chloritic or a fine amphibolitic schist inclosed in clay slate. This belt is greatly decomposed and filled with a great number of quartz seams carrying gold. The width of this auriferous zone is not exactly known, but a tunnel cutting across it about 150 feet below the croppings has shown it to be more than 130 feet. The whole mass of reddish decomposed rock and quartz is mined. It carries on an average from $1.50 to $2 per ton. The ore is quarried in a wide, open pit at the croppings and dumped down to the tunnel level through several roomy chutes. At the mouth of the tunnel, which is about 300 feet long, the mill is situated. The cars dump the ore over a grizzly down to the level of the rock breaker. The machinery consists of 3 Huntington mills, doing excellent work on the soft ore, a 10-stamp battery, and a rock breaker. The ore carries but little sulphurets, and these of a character hardly worth saving. The capacity of this plant is somewhat over 100 tons per day of 24 hours, say about 3,500 tons per month. The power station is situated at the mouth of Rock creek, 1,200 feet below the mill and 2 miles distant. A ditch owned by the company conducts the water of Rock creek half a mile above the mouth. At the station it has a head of 110 feet. It is drafted through a 5.5-inch nozzle to an 8-foot Pelton wheel giving 100 revolutions. 130 horse power is developed. The generator is a 100 horse power Brush dynamo with 900 revolutions per minute. The current is conducted to the mill and returned by means of a copper wire, No. 3, Brown & Sharp gauge. A 60 horse power Brush motor receives the current at the mill, and, running at 800 revolutions, transmits the power to the countershaft of the mill. The efficiency of the Pelton wheel is stated to be 86 per cent. The loss in conducting the current through the wire for 2 miles, measured by volts and amperes at the power station and at the mill, is about 10 per cent. The actual amount of horse power furnished at the countershaft of the mill as compared to that furnished at the shaft of the generator, that is, the efficiency of the whole electric plant, is not known at present and can only be ascertained by dynamometric measurements, but the probability is that it does not exceed 60 or 65 per cent. Besides producing electricity for motive power the generator runs incandescent lamps for lighting the mill. The plant was erected in the spring of 1890, the work being greatly retarded by the rainy weather and bad roads. It has been in continuous operation for about 5 months. The operating expenses of the whole plant are surprisingly small. The ore of the Dalmatia is mined and milled for 50 cents per ton. The mining is done by contract, the price per ton being 7.5 cents. The remaining 42.5 cents represents milling, management, and amortization of capital.